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Pikes Peak Educational Innovations and Research Symposium

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14. ABSTRACT

This report is a compilation of papers presented at the first annual Pikes Peak Educational Innovations and Research Symposium (PPEIRS), held at the US Air Force Academy, 20-22 January 1999. The papers in this report are categorized in four different tracks: Pedagogy, Information Technology, Assessment, and Miscellaneous. Within tracks, they are listed in the order, workshops, panels, and technical papers, and then by first author. The objective of the Symposium and the preparation of this report was to allow USAFA education researchers and innovators to describe their work to their colleagues. Except as noted, all authors are faculty, staff or cadets at the US Air Force Academy. The report includes a list of faculty and staff members who were or had been involved in education research In January 1999.

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INTRODUCTION

This report is a compilation of papers presented at the first annual Pikes Peak Educational Innovations and Research Symposium (PPEIRS; pronounced "peers"), held at the US Air Force Academy, 20-22 January 1999. The Symposium was organized because of the following perceived problem: Many USAFA faculty and staff were conducting "education research" but knew little of others' activities across academic departments, across academic divisions and across organizations at USAFA. The objective of the Symposium and the preparation of this report was to allow USAFA education researchers and innovators to describe their work to their colleagues.

The "education research" we discovered at USAFA varied widely, from pedagogical research through technology applications in teaching to studies aimed at curriculum redesign. Similarly, methods ranged widely from literature reviews through anecdotal data acquisition to survey data acquisition and performance data acquisition.

Early in the Symposium planning process, the Human-Environmental Research Center compiled a list of faculty and staff members who were or had been involved in education research. This list is shown in the Appendix for reference and archival purposes.

Session chairs for the Symposium were provided by the USAFA Faculty Forum. They included Lt Col Carl Boedigheimer (Dept of Mathematical Sciences), Dr. Ann Reagan (Dept of Philosophy and Fine Arts), Lt Col Russ Defusco (Dept of Biology), Lt Col Paula Britton (Office of the Registrar), Dr. Dan Pack (Dept of Electrical Engineering), Lt Col Tony Aretz (Dept of Behavioral Sciences and leadership), Lt Col Jim Pocock (Dept of Civil Engineering), Lt Col Pete Heinz (Dept of Foreign Languages), and Dr. Shane Burns (Dept of Physics). Our thanks to these individuals for a job well done.

The papers in this report are categorized in four different tracks: Pedagogy, Information Technology, Assessment, and Miscellaneous. Within tracks, they are listed in the order, workshops, panels, and technical papers, and then by first author. Except as noted, all authors are faculty, staff or cadets at the US Air Force Academy.

PEDAGOGY

Keynote Address

A Perspective on Liberal Arts Education

Timothy Fuller, Ph.D.
Dean, Colorado College
Colorado Springs, Colorado

Abstract: Much has been written in the last decade about the rapid changes in society and the need for adaptation by our social institutions, including those responsible for undergraduate education. American higher education is clearly rooted in the liberal arts model and several of the institutions in Colorado Springs, including the Air Force Academy, provide modern variants of this model. In this presentation, the Dean of Colorado College, a Liberal Arts I institution, provided his views on the value and future of liberal arts education in the United States.

Colonel Randy Stiles, in introducing Dr. Fuller, noted that the US Air Force Academy has a core curriculum derived from the liberal arts education model. He reminded us that the founding fathers of the Academy said things such as, "Be certain that the graduates of the Academy have an academic program that brings in the sciences, brings in the humanities, and blends them with their military professional education. Make sure they are prepared to be citizens of the world."

Dr. Fuller emphasized that innovation in education is important because the circumstances under which we conduct teaching and learning inevitably change. On the other hand, "There are certain fundamentally distinguishing features of liberal learning which persist through all the contingencies of fortunes and misfortunes of history." Thus, proponents of the liberal arts ideal must constantly wrestle with what to change and what to preserve.

In his talk, he described the distinguishing features of liberal learning, identified five challenges we face today, and suggested some appropriate responses.

Because we are creatures of reason, liberal learning is predicated above all on the freedom of choice where we can "imagine possibilities for ourselves that are not simply produced by the natural environment." Like Socrates, we have a "sense of duty to choose what is worthy to be chosen" and ultimately "to die in defense of the examined life." Such decisions are clearly passionate as well as rational.

"A part of what it means to become human cannot be satisfied in any other way than by reflective thought, by a life of study, and by a life of the mind." An unbroken tradition exists of establishing various institutions to provide places within society where people can "devote themselves consciously and undistractedly to the task of understanding and pursuing these things." Plato's Academy, the monastic schools of the early Middle Ages, the Medieval European universities, and the humanistic universities of the Renaissance created the study of the arts and sciences that we find now throughout modern institutions of higher education. These include schools of engineering, military academies, modern research universities, and liberal arts colleges. We are all part of that extended tradition, one that grants us "accumulated wisdom and insight," but that charges us with the responsibility of trusteeship: "We must be quite clear about what is important to preserve and carry forward so that subsequent generations will have the same benefit of inheritance that we have. It is always a

matter of innovation and preservation." We must add our voices to the conversation, but voices that do not expound "in a vacuum as if the past did not exist."

Two general points should enter into our thinking: (1) Learning, which is intrinsically good, can be an end in itself unjustified extrinsically by merely practical or utilitarian concerns; and conversely, (2) To organize and make sense of the world, learning always must have had "practical, professional, and vocational" ramifications.

Liberal learning, in both these manifestations, provides key resources. Because "successes and disappointments" come throughout a career, because it is impossible for "human beings to live in only a joyful state," we must draw on self-understanding and the ability to understand others. Such insights come not from technical training and specialization, but from "a deeper understanding of the human condition."

The challenges that face us in higher education today threaten these resources, but returning alumni with profound insights into life and learning and the continuation of institutions of higher learning from ancient to modern times sustains faith in both the value and the power of liberal learning.

Our challenges can be categorized as follows: abstraction, futurity or futurism, individualization, liberation, and secularization.

Abstraction refers to realities such as world markets, bureaucracies, ecological systems, and mass media which, because of their quantitative emphasis, weaken cohesive communities of support once taken for granted. With "atomization," anxious people feel abstractly united to one another only through large, impersonal organizations.

Futurity or futurism refers to the general processes of modernization, which focuses our attention away from the past to the future with an emphasis on innovation and change. Distancing ourselves from our inheritances as we embrace unknown but imagined future possibilities can result in "disorientation or a loss of one's way" when we neglect the "resources for reflection and decision that might be within our scope." Boredom or dissatisfaction with self are not valid excuses for turning only to future alternatives.

Individualization can result in an oscillation between demanding and protecting our autonomy and a distrustful longing for identification with some kind of community. "Liberation from the oppressive or the allegedly oppressive entities of tightly bound communities" sometimes results in a lack of orientation or a connection with the past.

Liberation from fate, or from fixed boundaries of thought and action, is compounded by the responsibility to choose "things that are really worthy to be chosen." This complexity is sometimes ignored by undergraduates who simply luxuriate in the ability to choose without recognizing the limitations to innovational options.

Finally, *secularization*, an antipathy to the dimension of transcendence, can circumvent traditional liberal education, which has traditionally emphasized a "sense of being called beyond oneself."

These challenges—conditions which are neither easily ignored nor corrected—reinforce the need for liberal learning. Intelligible, reflective, and critical responses emphasize responsible patterns of thinking and an awareness of what other human beings have confronted in the past.

The answers to the issues raised are not easy. But, "these are matters to which there are potential intelligent responses. The task of liberal learning is to cultivate the capacity for thoughtful and knowledgeable response."

Creating Learning Organizations in Higher Education: What? Why? And How? (Workshop)

David B. Porter, Ph.D., Colonel, USAF
Chair, Department of Behavioral Sciences and Leadership

Abstract: This workshop was about understanding educational processes and organizational renewal. It helped attendees appreciate how they can contribute to organizational transformation at various levels by creating authentic learning communities. The five disciplines of learning communities (systems thinking, team learning, vision sharing, mental modeling, and personal mastery) provided a foundation and framework for presenting numerous demonstrations, examples, and mini-exercises.

The mission of the USAF Academy is "*to develop and inspire air and space leaders with vision for tomorrow.*" However, one of the most essential means to this military end involves the process of integrating the core values of the military with those of higher education and conveying them to both faculty and students. External pressures caused by strategic global changes world have combined with internal factors to evoke significant changes to educational structures and processes at the Air Force Academy over the last decade. Is it possible that developments at this military academy might be relevant to the challenges faced by other higher education institutions?

In his recent work, <u>The Evolving Self. A Psychology for the Third Millennium</u>, Mihaly Csikszentmihalyi makes a key point about social organizations by contrasting an army unit with a typical university faculty:

> Social and cultural systems... can be more or less complex depending on how differentiated and integrated they are. An army unit, for instance, is not very differentiated: at each level of the hierarchy, individuals are more or less interchangeable. If you are a private, your identity may be interesting to you and your buddies, but as far as the army is concerned you are just a number. On the other hand, a well-run army tends to be highly integrated: each fighting unit is surrounded by smoothly functioning supply lines, medical services, and communication networks. Whatever happens to one unit has immediate consequences for all the others, and produces an adaptive response from them. A typical university is, in many ways, at the opposite extreme: each member of the faculty operates in splendid isolation from his or her peers; the emphasis is on original accomplishment and individuality, with little sharing of information or mutual assistance. It is in fact quite rare to find social institutions that maximize complexity by being both differentiated and integrated simultaneously, and when they are, they usually are so only for a short time, after which they again become either excessively rigid, or too unstructured. (p. 253)

Peter Senge offers learning organizations as a unique blend of integration and differentiation. He goes on to defined such groups as "*organizations in which people at all levels are collectively and continually enhancing their capacity to create what they really want*". Despite the variety of diverse examples of learning institutions, organizations and communities, they all share an appreciation and incorporation of five necessary *disciplines*. (A discipline is simply a practice or exercise that builds capacity over time.) These five disciplines are systems thinking, mental models, sharing vision, team learning and personal

mastery. Each of them is necessary and together they are sufficient to create and sustain learning communities.

Systems Thinking, Peter Senge's famous Fifth Discipline stresses the importance of understanding contexts and relationships. This first disciple opens the door to understanding and appreciating the other disciplines; it represents the broadest level of conceptualization. Systemic models of both educational and organizational transformation will be used to illustrate the advantages and insights provided by a systems perspective. Differences between *education* and *training* and their implications for assessment and continuous improvement will be briefly presented.

Team Learning involves learning about the growth and development of groups and communities as interdependent wholes. Building upon what participants learned about systems, they will consider how groups change. Characteristics of four distinctive stages of group development (forming, storming, norming, and performing) will show many of the potential difficulties inherent in the creation of effective teams. Discussion of the consequences of creating competitive vs. cooperative systems also will be presented briefly.

Mastery of the discipline of ***Sharing Vision*** requires the active and enthusiastic participation of all individual stakeholders in the organization. Traditional top-down approaches are unlikely to yield the quality of product or earn the ubiquitous individual commitment necessary to sustain systemic improvement. Conversely, a leader's failure to initiate the appropriate conversations about what is most important can lead to apathy and confusion. Some unique characteristics of the human visual processing system provide interesting metaphors for the development of vision sharing in educational organizations.

Mental Models, the penultimate discipline, reveals some of the underlying cognitive structures that profoundly influence our perception, thought and behavior. By articulating and sharing graphic representations of these structures, attendees will better understand their own and others' views of educational processes. An understanding of these mental models and the role they play in all human thought and memory, reveals the importance of frequently examining them and sharing them with others.

The discipline of ***Personal Mastery*** involves the appreciation of general principles of human growth and development as well as an understanding of one's own particular and distinctive strengths, weaknesses and preferences. Previous research has shown that a variety of distinctive learning styles and alternative approaches to a wide variety of educational activities can enhance organizational learning. This portion of the workshop will discuss implications of individual differences for comfort in a variety of educational activities including teaching, learning, and outcomes assessment.

Commitment to pursuing all five of these disciplines will inevitably increase an organization's understanding of its ultimate purposes and awareness of its most important processes. Pursuit of these disciplines also serves as a catalyst for continuous learning and quality improvement. Educational organizations are especially likely to benefit from adopting this broad conceptual framework.

The Collegial Classroom: DFBL's Efforts to Learn About Learning and its Implications for Classroom Teaching (Panel)

Robert C. Berger, Ph.D., Lt Colonel, USAF
Department of Behavioral Sciences and Leadership

Panel members: Col David B. Porter, Maj Kristen Vance, Dr. Steve Samuels, C1C James M. Ferrell, C1C Kari A. Hamilton, and C1C Andrew M. Quinn
Department of Behavioral Sciences and Leadership

Abstract: Over the past decade, many faculty members in USAFA's Department of Behavioral Sciences and Leadership have been actively seeking ways to enhance curriculum and pedagogy to enhance student learning. Recently, four particular pedagogical approaches have received increasing support within the department: curricular modularity, quiz-first, accept-resubmit enrichment projects, and benefit points. Together, these four approaches contribute to the development of a productive and encouraging atmosphere we refer to as *the collegial classroom*. This panel was comprised of students and teachers who had first hand experience with these approaches and their effects.

Over the past decade, many faculty members in the US Air Force Academy's Department of Behavioral Sciences and Leadership have been developing curriculum and pedagogy that enhance student learning. Many different initiatives have been explored. Collaborative and cooperative learning, interdisciplinary education, curricular integration, affective engagement, distributed practice, and embedded assessment have all been shown as ways of enhancing student motivation and learning. The overarching principle of this work is to move from a traditional *teaching focus* to more of a *learning focus* (Barr & Tagg, 1995). That is, moving from a point where the instructor is seen as the source of a one-way flow of knowledge to the students, and moving toward a point where the instructor is seen as a guide and facilitator to the students' seeking and attaining their own knowledge. This shift in approach turns the classroom into a more collegial setting by giving students more responsibility for their education, where the goal is a mutual learning environment for both teacher and student. This paper addresses four particular pedagogical approaches that have been put into practice within the department: curricular modularity, quiz-first, accept/improve papers, and benefit points.

Curricular modularity is the term used to describe an approach to course design based on the integration of topics into a coherent story. Over the long term, stories are much more memorable than lexicons or random collections of isolated facts and procedures. All too often, text availability is the primary determinant of course structure. There are always many texts available, but what makes a profitable or popular textbook is not necessarily the same thing that makes for a coherent or effective course. In fact, the market pressures that push texts to endeavor to be (and thus include) all things for all people and purposes, make many of them unsuitable as a framework for course design. By focusing first on broad themes, then on interlocking topics that support those themes, courses can be constructed before texts are selected. A text can then be chosen (or created) that supports the story the course hopes to convey. The course director can then select supplemental readings and enrichment projects to increase course coherence and coverage as needed.

No matter how good a text is, it will not contribute to students' learning unless they read it and reflect on the information it contains. The *quiz-first* approach is a useful method

of using just enough pressure to bring about general compliance with the course's classroom preparation requirements. Although there are various alternative forms of this approach, in general each module or block of material begins with a quiz. Quizzes are relatively brief, comprised of questions that tap material the student should have gleaned from reading the chapter. The quiz is completed in a single period and usually involves four distinct phases. First, students are given the opportunity to ask any questions about topics covered in the reading that were unclear or confusing. Next, they take the quiz individually. As soon as they have completed their individual quizzes, they form into groups of 3 or 4 students and retake the same quiz producing a single answer sheet. Finally the whole class convenes and discusses the quiz. Questions can be dropped due to ambiguity or credit can be given for multiple responses if appropriate. The grade students receive for a quiz is a weighted average of their individual score and their group's score. Note they can either gain or lose points based on their group's performance. While the quiz takes an entire period of class, all students (even the few who arrived relatively unprepared) have been engaged in substantive discussions of the most important aspects of the module topic by end of the 50 minutes. This leaves several more lessons for elaboration, experience, and application of the material, especially targeting that information that was least understood by the students.

Another example of collegiality is the *accept/improve* paper. Instead of assigning a letter or numerical grade, short papers now need to be "accepted". Those that demonstrate learning and are of excellent quality are accepted; those that are not receive feedback concerning needed improvements. This feedback is often in the form of questions the teacher would like answered based on the topics examined. Students may resubmit papers as many times as necessary to demonstrate learning and excellence. The final paper grade is based on the number of papers accepted over the semester. For example, a course could have 10% of the overall grade set aside for papers. Each of the first three accepted papers could count for thirty points, while the fourth could count for ten points. Those students who wanted to do the minimal work must have two papers accepted (60% of the possible credit). Those who wish to put forth more effort would ensure three papers were accepted (90%), and those who really wanted to put in maximal effort would work on all four (100%). This system allows students to demonstrate intellectual curiosity by exploring what they find intrinsically interesting.

Finally, *benefit points* can be used to place some the responsibility for assessment directly on the student. Somewhat like class participation points, benefit points are assigned based on how much the student's presence benefited the class. Talking too much (dominating) is not rewarded; nor is talking without saying anything. Listening and actively reacting to other students is ideal. Points can also be earned in other ways that benefit the class (e.g., feedback to the teacher about the course, feedback to other students by reading their papers, exploring topics outside of class and reporting, etc.). The assessment is made half by the student and half by the teacher. Both are blind assignments so that neither can "adjust" their score to take advantage of the other. The mutual assignment takes place at mid-term and final, and is non-cumulative. This allows students to learn to improve from their mid-term feedback, and does not allow those doing well to coast in the second half. It is important to note that the assessments are not merely subjective, but based on structured guidelines: clear expectations and explanations, possibly with handouts or behavioral profiles of what point assignments would look like. Additionally, any assessment over 70% must be justified by the student in a short correspondence to the teacher explaining why she or he

deserves the points (which can also serve as a form of course feedback). Then, teachers return the correspondence with their own assessment explanation of the student, effectively re-focusing them on both how he or she did and what is expected after mid-term. This approach increases students' perceived control in class, their self-efficacy for learning and helps lead them to believe they are being treated fairly.

All four methods we have discussed are consistent with the idea of moving from a teaching to a learning paradigm. These methods give students a significant amount of control over their grade and increase their responsibility for their own learning. Course critique data, majors' exit surveys, and graduation survey data suggest that collegial classroom techniques have a positive effect on learning and student enjoyment.

Reference

- Barr, R. B., & Tagg, J. (1995). A new paradigm for undergraduate education. *Change.* November/December, 13-25.

Helping Cadets Develop Their Skills for Framing and Resolving Ill-Defined Problems

Cindy Lynch, Ph.D.
Consultant
New Concord, Kentucky

Abstract: Faculty in engineering, legal studies, behavioral sciences, and other disciplines at the USAFA have been using innovative strategies to assess student performance and to help their students develop skills for framing and resolving ill-defined problems. Such problems do not have absolutely correct answers, and experts often disagree about optimal solutions. In this session, faculty shared some of what they had learned about students' skills and offered suggestions for classroom implementation of this cognitive developmental approach.

Over the past four years, several Air Force Academy faculty members have used a developmentally-grounded problem solving process as the foundation for helping students learn how to frame and resolve ill-defined problems. In contrast to well-defined problems that have a single, correct answer, ill-defined problems are fraught with significant and enduring uncertainties and ambiguities that preclude a single, correct answer. Based on a panel discussion of faculty experiences in using the problem solving model, several benefits were identified:

- Process provides opportunities to address a wide range of learning outcomes
- Very adaptable; direct faculty involvement in the design of activities and evaluation of performance
- Relatively efficient; provides both learning opportunities for students and assessment data for educators
- Theoretically and empirically grounded in human development so it provides a way to understand current performance and developmental steps between current performance and desired performance
- Dynamic skill theory explicitly addresses the interplay of personal and environmental characteristics; it has direct implications for curriculum refinements

Faculty also identified some common concerns about using this developmental approach. Some of the most important concerns are addressed below.

<u>Concern</u>: I'm not a developmental psychologist, and I'm unsure about how all this works.
<u>Suggestion</u>: For more information about assessing and optimizing students' skills for framing and resolving ill-defined problems, see *A Developmental Guide to Assessing and Optimizing Professional Problem Solving* (available electronically at <http://www.du.edu/~swolcott>). Engage in the problem solving process. Discuss your ideas with a colleague or Cindy Lynch. Make some minor change and see what happens.

<u>Concern</u>: Won't it be very time consuming to deal with each student's individual needs?
<u>Suggestion</u>: Again, start small. Be very aware of your own time constraints and those of your students. What might you delete from the work load to allow some time for innovative approaches? As you work with this model, the skill patterns will become more clear to you and you will become more efficient in recognizing and addressing individual needs.

Concern: Doesn't cognitive development take a long time? What if I can't demonstrate improvements during a semester?
Suggestion: Can you already demonstrate improvements in framing and resolving ill-defined problems during a semester? Most naturalistic environments do not provide the structure to help students exhibit their best performance. Providing the problem solving "roadmap" and opportunities for reflection and feedback can help students exhibit stronger performance and further develop their skills, even over the time-span of a semester.

Concern: I want my students to learn to take a stand and defend their opinion. Won't all this analysis just confuse them and give them an excuse to avoid a decision?
Suggestion: Many students learn to "play the game" of giving faculty what they think we want to see. They learn to "stack up" evidence to support a particular point of view. Although this is a precursor to the more complex framing skills, it is not sufficient. We may be encouraging superficial analysis. Ask your students to respond to some framing reflection prompts and see how they perform.

Concern: How will students respond to what I ask them to do?
Suggestion: While many students respond very positively to having this "roadmap" and become more engaged in learning, some students complain that the tasks are too difficult or that their current way of thinking suits them just fine (a "nobody knows so anything goes" approach). Emotions organize development; feelings can inhibit or motivate action. Attend to students' concerns. Provide clear instructions and examples. Conforming often precedes understanding. Listening and providing appropriate feedback is important. Adjust what you are doing as needed.

Reflective judgment research suggests that students with different skill patterns are likely to hold certain beliefs that hinder their performance (see *Developmental Guide* for lists of beliefs). These beliefs impact how they are likely to respond to ill-defined problems. Here are two common response patterns among undergraduates:

- Weak identifying, framing, resolving, and re-addressing: Students operating at this level expect "experts" to provide them with all answers, and thus are not likely to exhibit initiative in developing their own solutions to ill-defined problems.
- Adequate identifying, but weak framing, resolving, and re-addressing: Students operating at this level tend to be open to new situations, and they no longer expect experts to solve problems for them. However, they tend to be rather limited in their understanding of problems. While they assert that they are open to others' viewpoints, they often stack up support for their own position without giving careful consideration to alternatives.

If you would like more information about this developmental approach, please contact Dr. Cindy Lynch via e-mail (Leehaven@compuserve.com) or contact these USAFA faculty members: Lt Col Tony Aretz, Lt Col Jeff Jackson (Dept of Behavioral Sciences and Leadership); Maj Monty Greer, Maj Paul Waters (Dept of Engineering Mechanics); Lt Col Donna Peterson, Maj Cameron Wright (Dept of Electrical Engineering); or Maj Pam Perry (Dept of Law).

Igniting Intellectual Curiosity with "ICE"

Robert C. Berger, Ph.D., Lt Colonel, USAF
Steven K. Jones, Ph.D.
Department of Behavioral Sciences and Leadership

Abstract: One of the Academy's educational outcomes is to develop officers who are "intellectually curious." This paper briefly outlines a current theory of curiosity and explores assessment efforts that examine how well the Academy is meeting its outcome of graduating officers who are intellectually curious. We describe a course project designed to enhance intellectual curiosity that we have used for three years in one of our Behavioral Science courses and present student critique data evaluating the success of our project.

One of the United States Air Force Academy's educational outcomes is to develop officers who are "intellectually curious." The outcome further states, "Beyond possessing knowledge and having abilities to put that knowledge to active use, graduates of the Academy must be inclined to do so. We want to develop an attitude of intellectual curiosity in our graduates that predisposes them to lifelong learning" (United States Air Force Academy Educational Outcomes, 1997). The Academy is not alone in its quest for developing curiosity in its students. Curiosity has been described as being crucial to educational attainment (Day, 1982), and teachers are routinely encouraged to stimulate curiosity.

Over 100 years ago, William James (1890/1950) proposed that "scientific curiosity" arises from an "an inconsistency or a gap in ...knowledge" (p.429). James' early ideas about curiosity foreshadowed a current psychological theory of curiosity—the "information-gap" theory (Loewenstein, 1994). The information-gap theory takes the perspective that curiosity arises when one's attention becomes focused on a gap in one's knowledge. The theory states that curiosity is positively related to knowledge in a specific domain. As a student gains knowledge in a specific area it becomes more likely that the student will focus on what they do not know rather than what they do know. Therefore, it is not surprising that as knowledge in a domain increases, so does curiosity (Loewenstein, 1994).

These ideas make the pursuit of curiosity particularly appropriate for a major's course. Although some students may seek out situations that may make them curious, a more successful strategy in our fast-paced, demanding environment at the Academy may be to deliberately expose students to potentially curiosity-inducing stimuli. The Intellectual Curiosity Exercise (ICE) in Behavioral Sciences 336-Cognitive Psychology is designed to spark students' curiosity by exposing them to more in-depth information in their chosen major field of study by requiring them to read a book related to cognitive psychology. Based on their reading of the book, they make a oral presentation to the other members of their class, and they also complete a written paper.

The Academy has recently assessed how well the academic program has addressed the fostering of intellectual curiosity (United States Air Force Academy Educational Outcomes Assessment Working Group (EOAWG). Phase I: Final Report, November 1995). In a "Faculty Practices Survey," 93% of the faculty said that developing intellectual curiosity is either "important" or "very important" (EOAWG Report). The report also suggested several interventions that would help foster intellectual curiosity. These suggestions included incorporating more choice for students, more use of cooperative learning techniques, and

maintaining a more relaxed classroom atmosphere with more opportunity for personal interaction with instructors.

We also found during informal conversations with cadets that many admitted to having never read a non-fiction book that was not required for class, and that many cadets did not even read for pleasure. We also discovered that for many of our students the only exposure to their chosen major was through course texts and classroom lectures. We felt there were many contemporary books in the Behavioral Sciences area (some on recent best-seller lists, like *The Bell Curve* by Richard Herrnstein and Charles Murray, and *Emotional Intelligence* by Daniel Goleman) that our students would benefit from. We also thought that exposing them to reading about their major in a less structured, more informal setting, might lead to more spontaneous reading on their part. We felt that this in-depth reading could potentially highlight gaps in our students knowledge and increase their curiosity about psychology.

We developed the Intellectual Curiosity Exercise (ICE) which we have used for three semesters in Behavioral Science 336-Cognitive Psychology. An excerpt from the syllabus follows:

The ICE is one of the most unique and exciting aspects of this course. The goal is to give you the opportunity to read a book of your own choosing on a topic related to the field of cognitive psychology. You will then give a short presentation about the book to the class, as well as write a paper about what you have learned. This process will give you the chance to think deeply about the book that you read, and it will also give you the chance to learn at least a little bit about the books read by your classmates. There are really three required elements of the Intellectual Curiosity Exercise. They are: (1) Choosing and reading a book; (2) Giving a class presentation; and (3) Writing a paper about what you've learned. (Behavioral Sciences 336 Syllabus, Spring 1999)

We provide the students with a suggested list of books, but allow books not included on the list to be approved by the instructors. The exercise is modeled by course instructors who read a book from the project list and make an in-class presentation early in the semester. Students are encouraged to make their presentations informal and interactive. To complete the ICE, students schedule a personal appointment with their instructor to discuss what they learned from the project and to support their recommendation for a grade.

The ICE has a number of positive aspects that are consistent with the information-gap theory of curiosity and with the recommendations of the EOAWG Report. The project builds upon foundational knowledge by requiring them to read an in-depth treatment of a topic in cognitive psychology. This increases the likelihood that the student will recognize a gap in their knowledge, and hopefully will encourage them to address that gap. The exercise also gives students practice in distilling and communicating complex arguments through both the written and oral presentations. Finally, a number of characteristics of the ICE address issues related to those discussed in the EOAWG report: (1) choice is increased because students are allowed to choose their project; (2) students are actively involved, especially during their own oral presentation; (3) the classroom atmosphere during the classroom presentation is relaxed and open; and (4) the debriefing meeting that students have with their instructor allows for increased personal interaction between the student and the instructor.

We are currently using the ICE project for the third semester in cognitive psychology. We plan to develop more formal assessments of the project, but thus far student feedback has been encouraging. Critique data has shown that 77% of students agreed that the project

should be retained within the course and that 77% agreed that the project enhanced their intellectual curiosity. Enhancing students' intellectual curiosity is a specific goal of the Academy, and the ICE project, designed to be consistent with current theorizing about curiosity and incorporating recommendations from the EOWAG report, is a positive step toward addressing that outcome.

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"Quiz-First." An Anecdotal and Empirical Look at a New Teaching Pedagogy

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Abstract: This paper addresses a new teaching methodology being advocated and used quite extensively in the Department of Behavioral Sciences and Leadership at the USAF Academy. This methodology uses a "quiz-first" prior to teaching a block of material, in essence forcing the student to prepare for an assessment prior to an instructor led lecture. An anecdotal and empirical analysis of one class taught two different semesters using both a traditional lecture/exam format and a "quiz-first" format is presented. Both pro and con data will be presented, but a preference (in this class) for "quiz-first" method is advocated.

Introduction

At most institutions of higher learning, measurement of student learning in the classroom and assignment of grades has traditionally been made by the use of tests or exams given at periodic intervals throughout the semester or quarter. The exams typically covered material that was in a text and had been presented first in a classroom setting either by lectures, demonstrations, or student-led presentations. This paradigm has been around for many years and has been seldom challenged as the most effective method of assessing student learning. Samuels (1997) outlines a new methodology that radically changes this model. He proposes a "quiz-first" methodology that does away with traditional lecture-based exams, and instead has as its core assessment technique, quizzes that are given prior to covering the material. Instead of exams that cover large portions of the material, there would be several smaller quizzes administered prior to going over it in class. Following the quizzes is more traditional presentation of material. Samuels gives further supporting evidence as to the efficacy of this system. The focus of this paper is to report anecdotal and empirical evidence accumulated by me suggesting that this system is not only a very robust tool for assessing learning, but also encourages student learning more than the traditional approach.

I adopted this approach while course directing and teaching a class in *Engineering Psychology and Human Performance.* There two main reasons for this:

1) I was course director and only instructor for two successive semesters the course was taught.
2) Traditionally, the course received below department and USAFA averages for course critique data (this occurred the first time I taught it and I looked for ways to improve the receptivity of the course material)

The first semester (Fall '97) was a traditional lecture-based and exam type format. The following year (Fall '98) was taught using the quiz-first method. Following mid-course critique data that was remarkably positive compared to the previous time I taught it, I was encouraged to administer a subjective questionnaire to the students regarding student receptivity to the format.

Methods

Subjective questionnaires were administered at midterm and at the end of the semester. An analysis of end-of-course critique data from fall '97 and fall '98 was conducted as well as a comparison between final exam scores of the two semesters.

For the subjective questionnaire, a 7-point scale was used (7 indicated "highly agree", 1 indicated "highly disagree). Questions 1-13 addressed feedback for the instructor. Questions 14-23 addressed feedback about the course. The first three question were:

1. I preferred this method of assessment to the traditional GR method.
2. I retained information better with the quiz-first method compared to the traditional GR method.
3. I feel that I could have taken the quizzes without having studied for them and done fine.

Results

The results for the first three questions are indicated in Figure 1. All responses were significantly different from neutral, and there was no difference between midterm and the end of the semester.

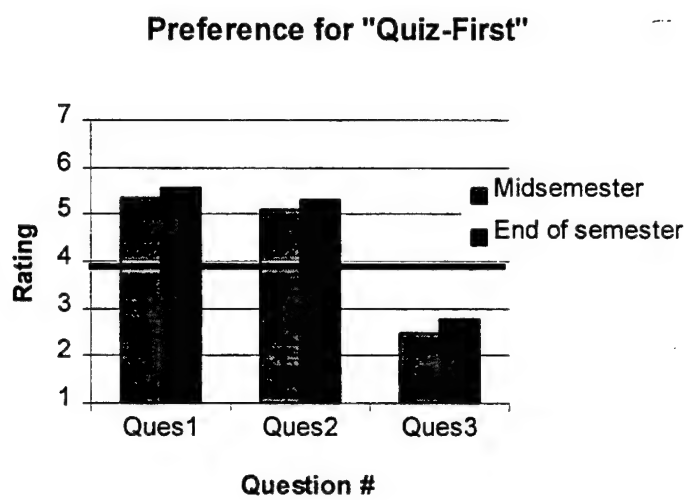

Figure 1. Subjective questionnaire results.

Figure 2 illustrates the improved overall acceptance of the course based upon end of course critiques. Note the improvements in every category.

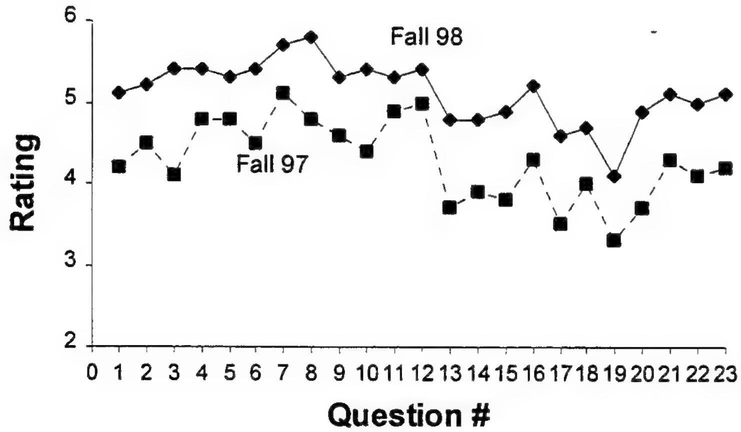

Figure 2. End of course critique data.

The final analysis was a comparison of final exam scores between the two semesters. There was a significant difference in the scores, with the traditional method of instruction obtaining a slightly higher average: 75.5% (fall 1997) vs. 72.6% (fall 1998), $t(85) = 2.058$, $p = 0.043$.

Discussion

Independent of the subjective analyses, the results of the final exam suggested that the efficacy of this teaching format should be questioned. However, there is a plausible explanation for the difference in final exam scores. The final exams were not exactly the same. Roughly 75% of the 1998 exam was the same as the 1997 exam. Unfortunately, due to the lack of primary data available from fall 1997, the similar questions could not be accurately identified or separated for analysis. Additionally, almost 40% of the questions for the final were given to fall 1997 students, prior to the exam. This was not the case for the fall 1998 students. Ostensibly, they could have come to the final exam better prepared to answer specific questions correctly. Although I was unable to asses this speculation quantitatively, a less than 3% difference in final exam scores could be viewed as operationally insignificant.

Anecdotally, there are several reasons that this appeared to be an effective format for enhancing student learning:

1) Students were put "in charge" of their own learning. They could no longer come to class unprepared and expect to be "spoon-fed" the material.
2) Students appeared to be more alert and attentive as a whole
3) Questions that students asked prior to quizzes and during lectures were more intelligent and inquisitive

On a personal level, there were many positive aspects of this methodology for the instructor. The format allowed me the flexibility to digress from the syllabus without fear of the students missing important material. If during a lecture the conversation drifted from the lesson topic to something else, I was comfortable with the fact that the students had seen the material before. If I didn't cover it in the lecture, all was not lost. They had read the material

and been tested on it already. This often gave me the opportunity to discuss "real life" cadet wing and Air Force issues with them.

Reference

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Encouraging Active Student Learning: Making Investing Relevant and Real

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Abstract: Making academic material relevant and real is important. This is particularly true for personal finance, because lessons from the financial "School of Hard Knocks" can impact a person for years. A pre and post-test study was used to examine the impact of studying and practicing investing as part of the Academy's core management class.

It does not matter how many times you were told not to touch a hot stove growing up; you only remember the result when you touched it yourself the first time. People remember and apply the lessons they experience from the "School of Hard Knocks" more than the information or advice they receive from other sources. The challenge for educators is to make academic material relevant and real so that the lessons from a more forgiving academic environment last as long as the lessons from the "School of Hard Knocks."

This is especially important in the realm of personal finance and investing because mistakes in this area can impact individuals for years. For example, a survey by Nellie Mae, the student financial aid organization, found the average credit card debt of undergraduates (between ages 18 and 25) was $1,879.[2] With an average credit card interest rate around 18 percent and paying a monthly minimum of $30 (assuming no additional charges were made), it would take 14.5 years and cost $4,375 to pay off this debt. The opportunity cost of not investing early is just as high because of the similar affect on compound growth in investments. Assuming a 12 percent annual return, a 22-year-old who puts $2,000 toward an IRA for only six years will end up with more money at age 65 than someone who waits until they are 28 to begin contributing to an IRA. This remains true even if the 28-year-old never stops contributing to the IRA through age 65.

At the Air Force Academy, the challenge of giving cadets the personal finance knowledge and experience they need is one task undertaken in the core management course, Management 210. During the fall of 1998, Management 210 cadets invested $100,000 of 'virtual' dollars in stocks, bonds, and mutual funds with the help of a real time stock market simulation website.[3] Initially, many cadets reported that they were intimidated by the project, but it did not take them long to identify with their investments. Additionally, classroom discussion was real and personal because it often related to course material to investments they had made. This paper reports on the process of moving cadets from intimidation to interest, and finally to active learning.

Research Questions

The primary goal of this study was to determine if combining course material with a real time experiential exercise would alter cadet intentions and behavior to invest. Several research questions were developed to see if the goal was achieved. The six questions I set out to answer included:

- What is the baseline financial experience of cadets?

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[1] Special thanks to Dr. Chirsty Strbiak for her mentorship on this study.
[2] Greene, Robert. "Study Finds Most College Students Use Credit Wisely," Denver Post, 25 Jun 98, p. 3C.
[3] http:\\library.advanced.org\10326\market_simulation\index.html

- What are the financial habits and intentions of cadets prior to the finance lessons compared to afterward?
- How confident are cadets on financial matters and does their confidence change over the course of the semester?
- How comfortable are cadets with managing their own investments and does it change over the semester?
- What is the knowledge level of cadets prior to the finance lessons compared to afterward?
- What level of risk tolerance do cadets have and does it change over the semester?

Methods

A pre and post-test experimental design was used during the fall of 1998 to measure the impact of the finance project and lessons. The personal finance lessons were presented at the beginning and end of the semester with the investment project running between the "book end" finance lessons. The initial finance lessons were designed to introduce terminology and concepts the cadets would need in order to successfully participate in the stock market simulation. The final finance lessons were designed to summarize the experience of the stock market simulation and reinforce the importance of personal finance.

Participants. Participants were a subset of the fall 1998 Management 210 course. Cadets were selected for participating in the research based on their assignment to the author's classes. Cadets were initially randomly assigned to all sections of the Introduction to Management course. This sample represented 77 of the 591 cadets enrolled. Participation in the study was voluntary. A survey was used to answer the research questions.

Measures. The questions for the survey included both questions from existing literature and questions developed for this study. The questions are presented in Appendix A. Questions on the pre and post-test were identical and designed to measure cadets investment experience, habits, confidence, intentions, knowledge, and demographic information. The number of subjects for the pre-test (n = 77) and post-test (n = 69) varied because of voluntary participation and absences for the day the pre and post-test were administered.

Parents' income (PI) was a self-reported measure of the total income by their parent's. The scale went from $35,000 to more than $120,000 with $20,000 between selections on the scale. Amount invested (AI) is a single item self-reporting the amount invested in stocks, bonds, or mutual funds. The scale included responses varying from not having anything invested to separately identifying amounts invested. Investing comfort (IC) was a single item measuring a self-reported response in reaction to a statement. The scale of the response went from strongly agree to strongly disagree. Finance confidence (FC) was a single item measure. It was a self-reported response to a statement with a scale from strongly agree to strongly disagree. Friends and family (FF) is a self-reported, single item measure of the frequency cadets talk with friends and family about investing. The scale of the response went from strongly agree to strongly disagree.

Television news (TV) was a self-reported, single item measure of the frequency cadets watched television news about investing or the stock market. The range of responses was from at least once a day to never. Newspaper news (NN) was a self-reported, single item measure of the frequency cadets read the business section of a newspaper. The range of the response was "at least once a day" to "never." Business periodicals (BP) was a self-reported,

single item measure of the frequency cadets read other business periodicals. The range of the response was "at least once a day" to "never."

Stock intent (SI) was a self-reported, single item measure of whether cadets intend to invest in stocks within the next year. The range of the response was "definitely" to "not at all." Bond intent (BI) was a self-reported, single item measure of whether cadets intend to invest in bonds within the next year. The range of the response was "definitely" to "not at all." Mutual fund intent (MFI) was a self-reported, single item measure of whether cadets intend to invest in stocks within the next year. The range of the response was "definitely" to "not at all."

Credit card payments (CCP) was a self-reported, single item measure of cadet habits in paying off their credit card debt. The range of the response was from not having a credit card to paying off the balance each month. Knowledge (K) was a multiple item measure of cadet knowledge about investing topics and the score was based on the number of correct responses. Risk (R) was a multiple item measure of risk based on responses to different scenarios. Different responses were weighted as involving varying levels of risk, and the risk weighting for each response was summed to create a score along a range.

The final stage of the research involved analyzing the data. Correlation analysis was used to determine how closely related the pre-test measures were to each other. It was also used to determine how closely related post-test measures were to each other. The pre- and post-test data were analyzed for significant differences between the means using a t-test for two independent samples (Sheskin, 1997). Ideally, a t-test for two dependent samples would be the most appropriate, but due to anonymity concerns data were not collected in matched pairs. Additionally, due to absences and voluntary participation sample sizes were not identical.

Results

The study had several significant findings. The findings are organized by reporting correlation among questions on the pre and post-test. Then results for which there were significant difference between the means on the pre and post-test are described.

Pre-Test. Knowledge was correlated with several factors. There was a significant relationship between knowledge and credit card payments ($r = .388; p \leq .01$), talking with friends and family ($r = -.317; p \leq .05$), investing comfort ($r = -.454; p \leq .01$), risk ($r = .309; p \leq .01$), and amount invested ($r = .301; p \leq .01$). Cadets with more knowledge about investing were more likely to pay off their credit card debt. Cadets with more knowledge were also to have higher comfort in managing their own investments and take on more risk. Finally, cadets who had more knowledge were more likely to already have money invested.

Additionally, finance confidence was correlated with investing comfort ($r = .405; p \leq .01$). The more confident a person was in managing their day to day finances the more comfortable they were with managing their own investments. There was also a significant relationship between talking with friends and family and a cadet's investing comfort ($r = .517; p \leq .01$), and amount invested ($r = -.377; p \leq .01$). The more a cadet talked with friends and family about investing the more likely they were to be comfortable with investing and to have money invested.

The frequency with which a person would look at one news source (TV, newspaper, or periodical) was closely correlated with whether they looked at other sources. There was a significant relationship between watching television news and newspaper reading ($r = -.397; p$

$\leq .01$), and reading business periodicals ($r = .517$; $p \leq .01$). This meant that a cadet that looked at one source of investing or business news was more likely to look at other sources of news.

Post-Test. Knowledge was correlated with several factors. As in the pre-test, there was a significant relationship between knowledge and investing comfort ($r = -.336$; $p \leq .01$), and talking with friends and family ($r = .260$; $p \leq .051$). The higher knowledge scores related to higher investing comfort and frequency of talking about investing with friends and family. For the post-test only, knowledge was correlated with finance confidence ($r = -346$; $p \leq .01$), newspaper reading ($r = .368$; $p \leq .01$), and business periodicals ($r = -.248$; $p \leq .05$). Cadets demonstrating higher knowledge were more likely to look at newspapers and business periodicals.

As in the pre-test, the relationship between finance confidence and investing confidence was significant ($r = .552$; $p \leq .01$). On the post-test, finance confidence had a significant relationship with friends and family ($r = .361$; $p \leq .01$), newspaper news ($r = .351$; $p \leq .01$), and credit card payments ($r = -.365$; $p \leq .01$). Cadets with higher finance confidence were more likely to talk and read about investing. Additionally, cadets with higher finance confidence were more likely to pay off credit card debt each month.

Unlike the pre-test, the frequency with which a person would look at either TV or periodicals was closely correlated with what investment they intended to make. There was a significant relationship between watching television business news and stock intent ($r = .427$; $p \leq .01$). There was also a significant relationship between reading business periodicals and stock intent ($r = .467$; $p \leq .01$). Cadets reading newspaper news or business periodicals were more likely to have intentions of investing in stocks. There was also a significant relationship between reading business periodicals and mutual fund intent ($r = .256$; $p \leq .05$). Cadets reading business periodicals were more likely to have intentions of investing in mutual funds.

Tests of Means. The question, "How comfortable are cadets with managing their own investments and does it change over the semester?" was tested. There was a significant change in investing comfort ($p \leq .001$) from the beginning of the semester (mean = 3.06) and the end of the semester (mean = 2.07). Cadets became more comfortable handling their own investments. The question, "How confident are cadets on financial maters and does their confidence change over the course of the semester?" was also tested. The change in confidence for handling day to day finances was also significant ($p \leq .05$), pre-test (mean = 2.00), and post-test (mean = 1.68).

Next the question, "What is the knowledge level of cadets prior to the finance lessons compared to afterward?" was tested. There was a significant change in investing knowledge ($p \leq .001$) from the beginning of the semester (mean = 2.38) and the end of the semester (mean = 5.20). Cadets became more knowledgeable about investing over the course of the semester.

Finally, results showed that cadets changed their habits over the course of the semester. The first habit tested was talking to friends and family. There was a significant change in the amount that cadets talked with friends and family about investing ($p \leq .001$) from the beginning of the semester (mean = 2.52) to the end of the semester (mean = 1.80). Cadets were more likely to talk about investing after taking Management 210. Next, investing habits were examined. The different investment vehicles (stock, bond, and mutual fund) were tested for significant change. No significant changes occurred from the pre-test to

the post-test on stock or bond intent ($p \leq .2$). However, there was a significant change for mutual fund intent ($p \leq .05$). Cadets were more likely to invest in mutual funds after the course (x = 1.46) than before (x = 1.73). This showed that cadets learnēd that the best investment based on diversification, professional management, and long-term returns was a mutual fund, and adjusted their future investing plans accordingly.

Discussion

In general, I set out to answer six questions. The original questions with the answers summarized follow. The first research question involved determining the baseline financial experience of cadets. Results of the pre-test showed that cadets investing experience was bimodal. Thirty-seven of the 77 cadets had not invested in stocks, bonds, or mutual funds at the beginning of the project, while twenty-five had over $5,000 invested in financial instruments. The remaining fifteen cadets had less than $5,000 invested. Even though 48% of the cadets had money invested, in-class interactions showed they were apprehensive of the finance project at the beginning of the semester. The reason for this was that the finance project was the first time most of them would make actual decisions about companies or funds to select as investments.

The second research question involved determining changes in the financial habits and intentions of cadets before and after the finance lessons. There was a significant change in the amount of discussion about investing that cadets had with friends and family. This could be explained by the fact that investing was a requirement of the course, except for qualitative comments from cadets that once they started investing they found it interesting and wanted to learn more. Exposing cadets to finance in Management 210 removed the fear and mystery of investing, and increased the likelihood that they would talk about financial matters. The only significant change in cadet investment intentions was that cadets were significantly more likely to invest in mutual funds after the finance lessons.

The third and fourth research questions involved determining changes in cadet confidence on financial matters and comfort with investing before and after the finance lessons. In general cadets were confident in their ability to handle their day to day finances throughout the semester. However, cadet comfort with handling their investments increased significantly.

The fifth research question involved determining changes in the knowledge level of cadets before and after the finance lessons. On the average, cadet knowledge on investing, like the general publics, was low. The average knowledge level of cadets after the finance lessons increased from an average correct of 2.37 out of 9 questions to 5.2 correct or 57.8 percent. Based upon participation in class, cadet investing knowledge was taken from below average to an approximately average level compared to mutual fund investors. This observation was based upon a comparison of cadet results to the results of 1,555 mutual fund investors on a twenty-question survey by Vanguard for which the average score was 51%.[4] Thus, cadet knowledge increased to a level similar to general mutual fund investors.

The final research question involved determining changes in cadet investment risk tolerance. On the average, cadets were moderate to aggressive risk takers throughout the semester. In the pre-test, there was a significant correlation between risk and finance confidence ($r = -.319; p \leq .01$), and knowledge ($r = .309; p \leq .01$). This meant that more knowledgeable and confident cadets were comfortable with more risk. However, correlations

[4] -----, "Mutual Fund Literacy Test," Vanguard Marketing pamphlet, 1998, p. 1.

among the multiple risk questions had a low Cronbach alpha, suggesting that the questions may not have measured the same factors of risk.

The study had a number of limitations. First, generalizing the results of this study to college students in general may be difficult. As noted earlier, cadet responses on the pre- and post-test were not paired. Additionally, the risk measure questions may not have measured the same factors of risk. Other issues dealt with the stock project. During the semester, problems with the Internet server used by cadets detracted from stock market simulation because cadets often were unable to access it. Also, the stock market experienced a correction at the beginning of the project. Recommendations for future studies include: using a control group, collecting data in matched pairs, and correlating both initial experience and confidence with the results of the investment game.

Summary

This study highlighted a number of interesting issues. First, cadets that already had money invested in financial instruments were more likely to pay off their credit card in full each month and talk with friends and family about investing. Additionally, cadets with prior investing experience tended to know more about investing from the very beginning. Finally, cadet knowledge on investing in general was low. This is a concern because poor financial decisions now can have long lasting impacts. The majority of participants were either juniors or seniors and avoiding financial problems is part of a successful military career.

Fortunately, investing knowledge increased to at least the average level of mutual fund investors in general by the end of Management 210. Another positive indication on the post-test was that knowledge was correlated with comfort in managing their investments, or investing comfort was supported by better knowledge about investing. Additionally, the only significant change in investing intentions involved mutual funds. This can be viewed positively because mutual funds offer lower risk because of diversification than direct investment in stocks.

In conclusion, active involvement and presentation of course material in Management 210 changed cadets' knowledge, behavior, and investing intentions. Because the finance lessons and project dealt with "virtual" dollars, negative consequences could be experienced without long-term financial harm. Learning similar lessons from the "School of Hard Knocks" with their hard-earned money would be less forgiving. Ideally, each cadet's investing experience in Management 210 gave them relevant experiences that should help them avoid financial lessons from the "School of Hard Knocks." Several cadets also showed interest in continuing to learn about investing, reinforcing the observation that cadet behavior and intentions were modified. Finally, when cadets who experienced the Management 210 finance lessons become officers, they should be more likely to make better investment decisions.

Reference

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Appendix A: Pre/Post-Test

Section 1: Background Questions

1) What amount do you currently have invested in stocks, bonds, or mutual funds?
   a. Do not have investments in stocks, bonds, or mutual funds
   b. Have investments in stocks, bonds, or mutual funds but do not know value of investment
   c. $1 to $1000
   d. $1001 to $5000
   e. Over $5000

2) What is your reaction to the following statement: "I am comfortable with managing my own investments for retirement and other goals."
   a. Strongly agree
   b. Agree
   c. Neither Agree/Disagree
   d. Disagree
   e. Strongly disagree

3) What is your reaction to the following statement: "I am confident in my ability to manage my day to day personal finances."
   a. Strongly agree
   b. Agree
   c. Neither Agree/Disagree
   d. Disagree
   e. Strongly disagree

4) What is your reaction to the following statement: "I talk about investing with friends and family."
   a. Strongly agree
   b. Agree
   c. Neither Agree/Disagree
   d. Disagree
   e. Strongly disagree

5) How often do you do watch TV news talking about investing or the stock market?
   a. At least once a day
   b. More than once a week
   c. About once a week
   d. Once a month or less
   e. Never

6) How often do you read the business section of a newspaper?
   a. At least once a day
   b. More than once a week
   c. About once a week
   d. Once a month or less
   e. Never

7) How often do you read other business-related periodicals?
   a. At least once a day
   b. More than once a week
   c. About once a week
   d. Once a month or less
   e. Never

8) Do you intend to invest money in stocks in the next year?
   a. Definitely
   b. Maybe

    c. Not at all

9) Do you intend to invest money in bonds in the next year?
    a. Definitely
    b. Maybe
    c. Not at all

10) Do you intend to invest money in mutual funds in the next year?
    a. Definitely
    b. Maybe
    c. Not at all

11) When you make your monthly credit card payments, do you?
    a. Do not have a credit card
    b. Make the minimum payment
    c. Pay more than the minimum payment, but less than half the complete balance
    d. Pay more than the minimum payment and pay more than half the complete balance, but less than the complete balance
    e. Pay off the complete balance every month

12) You work for a small, but thriving, privately held electronics company. The company is raising money by selling its stock to employees. Management plans to take the company public, but not for 4 more years. If you buy the stock you will not be able to sell it until the shares are traded publicly. In the meantime, the stock will pay no dividends. But the shares could trade for 10 to 20 times more than what you paid for them when the company goes public. How much would you invest in the company?
    a. Nothing
    b. One month's salary
    c. Three month's salary
    d. Six month's salary

13) You are on a TV game show and can choose one of the following. Which one would you choose?
    a. $1,000 cash
    b. 50 percent chance of winning $4,000
    c. 20 percent chance of winning $10,000
    d. 5 percent chance of winning $100,000

14) You have lost $500 at the blackjack tables in Las Vegas. How much more are you prepared to lose to win the $500 back?
    a. Nothing
    b. $100
    c. $250
    d. $500
    e. Over $500

15) Your investment loses 15 percent of its value in a market correction a month after you buy it. Assuming that none of the fundamentals have changed, do you:
    a. Sit tight and wait for it to journey back up
    b. Sell it and rid yourself of further sleepless nights in case it continues to decline
    c. Buy more--if it looked good at the original price it looks even better now

16) Have you participated in an investing or stock market game before?
    a. Yes
    b. No

<u>Section 2: Topic Questions</u>

17) If you buy a $10,000 bond paying 10 percent interest, what happens to the value of the bond when interest rates fall?
    a. Do not know

b. The value of the bond does not change
c. The value of the bond increases
d. The value of the bond falls

18) Dividing a company's share price by a summary of its last four quarter's earnings is a method of finding the:

a. Do not know
b. PE ratio
c. Dividend yield
d. Current ratio
e. Profit margin

19) What stock market average represents 30 "Blue Chip" stocks trading on the NYSE?

a. Do not know
b. S&P500
c. Russell 2000
d. Dow Jones Industrial Average
e. Wilshire 5000

20) When a company increases the amount of stock to reduce its share price by issuing stockholders additional shares, this is called a:

a. Do not know
b. Short sale
c. Stock split
d. Capital gain
e. Goodwill

21) When a company announces a corporate takeover, what generally happens to the share price of the company being acquired?

a. Do not know
b. Takeovers do not impact share prices
c. Share price increases
d. Share price decreases

22) A mutual fund that tries to maintain a net asset value of $1 by investing in short term securities is called a:

a. Do not know
b. Bond fund
c. Balanced fund
d. Money market fund
e. Equity fund

23) What type of investment has historically provided the best protection against inflation?

a. Do not know
b. Stocks
c. Bonds
d. Savings accounts
e. Real estate

24) If two mutual funds hold the same securities, but one has higher operating expenses than the other, what is the impact on the fund's return?

a. Do not know
b. The fund with the higher expenses will have a higher return
c. The fund with the lower expenses will have a higher return
d. Operating expenses do not impact fund returns

25) In general, which of the following types of mutual funds is likely to decline the most when the overall stock market falls?

a. Do not know
b. Aggressive growth fund
c. Growth and Income fund
d. Bond fund
e. Money Market fund

26) Who was President of the United States during the 1929 market crash?
a. James Garfield
b. Hubert Hoover
c. Calvin Coolidge
d. Teddy Roosevelt

Section 3: Demographics

27) What is your gender?
a. Male
b. Female

28) What class are you in?
a. Firstie
b. 2 degree
c. 3 degree
d. Doolie

29) What is your age?
a. 25 or 26
b. 23 or 24
c. 21 or 22
d. 19 or 20
e. 17 or 18

30) What is your parent's income?
a. More than $120,000
b. $75,000 to $119,999
c. $55,000 to $74,999
d. $35,000 to $54,999
e. under $35,000

Designing an Honors Leadership Seminar

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Abstract: During the Spring of 1998, I was given the opportunity to create a unique leadership course for a section of firstclass and secondclass behavioral sciences majors. The structure of the course emphasized student involvement in developing and delivering the leadership lessons. Student critique ratings reflected overall student satisfaction with this new approach.

Background

During the Spring of 1998, I was given the opportunity to create a unique leadership experience for a section of firstclass and secondclass behavioral sciences majors enrolled in Behavioral Sciences 310, Leadership Concepts and Applications. As the only academic course in leadership offered to cadets during their four years at USAFA, Behavioral Sciences 310 had evolved over the years to be primarily a survey course covering a variety of basic psychological principles and theories as they applied to the concept of leadership. Having taught this course using the traditional textbook/syllabus approach for several years, I was curious to try a new approach that would take advantage of the leadership training and experiences students have outside the classroom as cadet leaders and followers. Since Academy cadets are probably more familiar with general leadership issues than typical college students attending the same kind of course, I've always toyed with the idea of allowing my students to create their own leadership experience in the classroom. This fantasy came true last Spring semester.

The First Day

Place yourself in the role of one of my students attending the first day of class who hears me say, "In this course, there will be no textbook, syllabus, assigned readings or periodic quizzes/Graded Reviews. Everyone in this class will be responsible for working together to create an effective learning environment for studying leadership, beginning with the development of an appropriate syllabus due on Lesson 10. The material for the course can come from the 30 or so leadership references that I will make available to you or any other leadership source you may discover. You may organize yourselves as you see fit to accomplish the assigned tasks. Are there any questions?" Student reaction ranged from disbelief, to joy, to mistrust, to "why me?" One objective of this approach was to provide a forum where students would directly participate in leadership/followership interactions while, at the same time, developing a plan for studying these phenomena.

The Plan

While student choice and flexibility were the major themes of this course, there was a certain amount of structure imposed to focus their learning experience. First, a syllabus was required which, among other things, specified the content and sequencing of ten student-led discussions beginning on Lesson 12. Working in pairs, students were responsible for selecting, designing, and delivering a 50-minute lesson on a leadership topic of their choice. During the lessons leading up to the student presentations, I would construct short lectures, lead discussion groups, and conduct various classroom leadership assessment exercises to create the framework for future leadership discussions.

A leadership case study construction exercise was scheduled to kick off the second half of the semester. Cadets worked in groups of four to create richly detailed cadet-based leadership scenarios, including a recommended resolution of the issues; that could be used to illustrate the concepts discussed in class. Each group would then be handed another group's scenario and asked to resolve that scenario, first as individuals outside class and, later, as groups in class.

The last third of the semester was reserved for cadets to prepare and carry out their final projects. The projects required student groups to consult with selected base organizations on a particular leadership issue. Through this partnership, the cadet consultants helped their organizations define the relevant leadership issues, develop alternative strategies to deal with these issues, and implement the selected approach. The results were written up in a project paper and presented to the rest of the class during a fifty-minute briefing.

Students were also required to take a final exam which consisted of 3 essay questions designed to integrate student learning across the semester.

In addition, my students participated in many of the special activities associated with the general course including an "Airman" panel, a "Noncommissioned Officers" panel, and the Leadership Reaction Course. And finally, my students were required to record up to six personal leadership experiences throughout the semester using the Action-Observation-Reflection (AOR) model of experiential learning.

The Results

The results of this unique classroom experience greatly exceeded my expectations as the instructor. In general, the overall amount and quality of leadership discussions were unmatched by any class I've seen in my ten years of teaching at the Academy.

Several student products were evaluated, in part, by outside instructors with the criteria developed by students in consultation with myself. For example, the class syllabus was graded by five instructors including the Course Director for the main course. All evaluations were A- or higher. A similar process was used for evaluating the content of the case studies where grades ranged from B+ to A. In addition, other instructors would report that some of my students would initiate conversations in their courses concerning the exciting and positive experiences that were going on in my class.

Student performance was higher in my section as indicated by an overall section GPA of 3.4 compared to a course GPA of 3.2.

Probably the most powerful evidence for the effectiveness of this course on student learning came from the student critique ratings measured at the end of the semester. Using a six-point scale, the mean student rating for 310 Honors across the ten course dimensions was 5.4 compared to 4.7 for the rest of the course. In particular, Intellectual Challenge and Independent Thought dimension was 5.5H/4.7, while Amount Learned was 5.6H/4.6.

For me personally, the most satisfying result occurred whenever students from this section would approach me afterward to ask if I was planning to teach another course using the same approach so that they could consider trying to fit it into their already tight schedules. That was the most persuasive evidence I needed to keep pushing for greater student control in the classroom.

Distributed Practice: More Bang for Your Homework Buck

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Abstract: Homework is commonplace in math classrooms, yet little research has been conducted on the differential effectiveness of homework for students with varying aptitudes. In this study, distributed practice homework bolstered the achievement of low achieving college math students. The sample consisted of 351 US Air Force Academy cadets all in their first semester of college. An algebra/trigonometry placement exam measured prior mathematics achievement and a subset of 25 items from the Math Anxiety Rating Scale measured math anxiety (Alexander & Martray, 1989). Data were analyzed using hierarchical multiple regression. Treatment group students outscored control group students on 4 of the 6 achievement measures without regard for prior math achievement or math anxiety (alpha = .05).

Homework is commonplace in college mathematics courses, yet, with the exception of the inconclusive research investigating Saxon's incremental continuous review method (Abrams, 1989; Denson, 1989; Gianniotes, 1989; Johnson & Smith, 1987; Klingele & Reed, 1984; Parker, 1990; Reed, 1983; Rentschler, 1995; Roberts, 1994; Saxon, 1982), little research has been conducted on the content or quality of mathematics homework or on homework's effect on achievement. Other than a small study conducted by Hirsch, Kapoor, and Laing (1982, 1983; $\underline{N} = 52$ first semester college calculus students), there is a lack of research investigating the differential effectiveness of homework for students with varying aptitudes (Austin, 1979; Featherstone, 1985; Hirsch et al., 1982, 1983; Kohler & Grouws, 1992; Peterson, 1971; Suydam, 1985). College students placed into precalculus and algebra courses have not yet mastered the fundamentals of algebra required to succeed in calculus. Many of these students have learned algebra as a set of rules for attacking specific types of problems. Homework problems in algebra courses usually consist of a set of problems related to the most recent problem type, that is, massed practice. With massed practice, students do not practice learning to differentiate between problem types. Yet, success in calculus requires students to determine when and where to use a variety of algebraic techniques.

By assigning homework problems related only to the most current course topics, mathematics educators have ignored the findings of cognitive psychology research recommending spaced over massed practice (Dempster, 1988, 1989; Reynolds & Glaser, 1964). Distributed practice is based on the aspect of information processing learning theory known as the <u>spacing effect</u>.

The spacing effect is the phenomenon in which "for a given amount of study time, spaced presentations yield substantially better learning than do massed presentations" (Dempster, 1988, p. 627). The spacing effect has a long history in cognitive psychology and education research and is also referred to as distributed practice, continuous review, and spaced review (Cuddy & Jacoby, 1982; Dempster, 1988; Krug, Davis, & Glover, 1990; Reynolds & Glaser, 1964; Toppino & Gracen, 1985; Underwood, 1961). According to Dempster (1988), although distributed practice is "one of the most remarkable phenomena to emerge from laboratory research" (p. 627), there is little evidence that its potential has been realized in applied settings.

Research on distributed practice is situated in information processing theory (Ausubel,

1966). For over 25 years, cognitive psychology research has documented the benefit of spaced practice (Cuddy & Jacoby, 1982; Krug et al., 1990; Melton, 1970; Modigliani, 1976; Rea & Modigliani, 1985; Toppino & Gracen, 1985; Thorndike, 1971; Underwood, 1961). The most typical finding of this research was that as spacing increased, retention also increased. However, most research pertaining to the spacing effect has investigated the learning of simple word or number lists with time lags measured in seconds. Although the spacing effect is "one of the most robust phenomena discovered in memory research" (Rea & Modigliani, 1985, p. 11), results from cognitive psychology experiments do not necessarily transfer to complex learning tasks with longer spacings between reviews (Reynolds & Glaser, 1964). According to Dempster (1988), studies conducted from a basic research perspective and those conducted from an applied perspective frame two distinct research strands.

According to Cronbach and Snow, "an interaction is said to be present when a situation has one effect on one kind of person and a different effect on another" (1977, p. 3). Salomon (1972) described aptitude-treatment interaction (ATI) research as accomplishing two functions: improving instruction and advancing instructional theory. Salomon's compensatory ATI model proposed that ATI treatments could be developed to interact with aptitudes by circumventing their debilitating effects without trying to improve them. Snow (1977) advocated the use of some measure of general ability in all instructional research. Whenever affective traits are considered, researchers should expect that the regression of the trait will vary with ability. Cronbach and Snow (1977) assert that the anxiety experienced by an individual depends on the difficulty he or she has with a task. Task difficulty depends on an individual's ability and the characteristics of the task. Therefore, a complex task is more likely to create anxiety in persons of low ability than in more able persons (Cronbach & Snow).

From an ATI standpoint, Tobias (1976, 1989) hypothesized that students with lower prior achievement require more instructional support, and conversely, that as the level of prior achievement increases, less instructional support may be required. In their review of ATI research in science education, Koran and Koran (1984) referred to task organization as a manipulation likely to have an obvious effect on learning and a clear implication for ATI research. That is, material that is well organized should result in better achievement for high anxiety students (Koran & Koran, 1984). Similarly, Tobias (1989) and Bessant (1995) recommended clearly structured instruction as beneficial to highly anxious students. According to Sieber, O'Neill, and Tobias (1977), students high in anxiety may also benefit from opportunities for repetition of selected parts of the content.

In this study, the spacing principle was applied to Precalculus homework assignments (Hirsch et al., 1982, 1983; Peterson, 1971). The purpose of the study was to explore distributed practice homework assignments as one way to provide the instructional support and task organization necessary to increase the mathematics achievement of students with low prior mathematics achievement, high levels of mathematics anxiety, or both.

Three research questions were established:

1. Will distributed practice homework assignments have a positive effect on Precalculus achievement?
2. Will distributed practice homework assignments have a greater positive effect on Precalculus achievement than traditional homework assignments for students with low prior mathematics achievement?
3. Will distributed practice homework assignments have a greater positive effect on

Precalculus achievement than traditional homework assignments for students with high mathematics anxiety?

Methods

Participants. The sample for the study consisted of all 375 United States Air Force Academy (USAFA) cadets enrolled in Precalculus during the 1995 fall semester. Enrollment in Precalculus was based on placement exam scores. Students scoring less than 50% on the Algebra/Trigonometry placement exam were placed into Precalculus. The sample represented about 28% of the first year students. Of the remaining first year students, 519 (about 39%) were placed into Calculus I, 344 (about 26%) were placed into Calculus II, and 103 (about 8%) were placed into Calculus III. All USAFA students are required to complete a sequence of core courses which includes at least two semesters of Calculus.

Natural attrition of students resulted in a changing sample size during the semester. At the time of the first exam, 351 of the original 375 cadets enrolled in Precalculus remained. Enrollment was 341 at the time of the second exam, 338 at the time of the third exam, and 333 at the end of the semester.

The USAFA has high admission standards. To qualify for admission, students must have good grades and athletic and leadership experience (Air Force Academy Admissions Office, 1995). In addition, students must be unmarried, without dependents, and between the ages of 17 and 21 (Air Force Academy Admissions Office). The mean Scholastic Achievement Test (SAT) math achievement score for incoming Air Force Academy students was 660 (recomputed to reflect the 1995 recentering of the SAT) and the mean for the math portion of the American College Test (ACT) for incoming students was 29.3 (B. A. Branum, personal communication, September 6, 1995). The average high school grade-point average for incoming cadets was 3.85 (B. A. Branum) and 89% of entering cadets ranked in the top fifth of their high school class (Air Force Academy Admissions Office).

The USAFA class of 1999 consisted of 1367 students, 1353 from the United States and 14 from 13 foreign countries (Lockhart, 1995). Included were 238 minority members (17%) and 219 women (16%). Of the United States students, 1086 (82%) were White, 56 (4%) were Black, 85 (6%) were Hispanic, 72 (6%) were Asian American, and 19 (1%) were Native American (B. A. Branum, personal communication, September 6, 1995).

Prior Mathematics Achievement. The percentage correct on an Algebra/Trigonometry placement exam was used as the measure of prior mathematics achievement. The placement exam contained 35 multiple choice items (25 algebra items and 10 trigonometry items) and was machine scored. The test was validated for content in 1995 by faculty members of the USAFA math placement team. The tests were found to have high predictive validity for placing students into Precalculus as their first mathematics course, with 87% of students successfully completing Precalculus with a grade of B+ or less (A's and A-'s were considered erroneously placed; W. A. Kiele, personal communication, April 5, 1995). Many of the placement test items are <u>anchored</u>, that is, used again from year to year. The use of anchored items improves test stability and reliability.

The placement exams were administered under standardized conditions a few days after the students arrived at the Air Force Academy. Students took the exam in large lecture halls proctored by instructors. Standardized directions were printed on the first page of the exam and read aloud by the proctors. All students had identical time limits. The use of calculators was not permitted.

Mathematics Anxiety. Mathematics anxiety was measured by a subset of items from the Math Anxiety Rating Scale (MARS), college and adult version (Suinn, 1972). The MARS is a 98-item self-rating scale set in a five point Likert format designed as a diagnostic or screening tool for measuring mathematics anxiety. Scores on each MARS item represent the level of anxiety reported for a specific situation. Selections range from 1 representing "not at all anxious" to 5 representing "very much anxious." An overall mathematics anxiety score is achieved by summing the individual item scores.

Since its publication in 1972, the MARS has been the prevailing instrument for measuring mathematics anxiety (Alexander & Martray, 1989). Alexander and Martray (1989) used a two-staged factor analysis to develop an abbreviated version of the MARS. Their first factor analysis reduced the 98-item MARS to 69 items by selecting the items most highly correlated to each of five identified factors. The 69-item MARS was again abbreviated by application of factor analysis. Items that correlated highly with each of three identified factors were selected for Alexander and Martray's 25-item abbreviated MARS. The 25-item MARS was shown to have high internal consistency within each of the three factors (Cronbach alpha of .96, .86, and .84, respectively). In addition, correlation between the 25-item and 69-item versions of the MARS was found to be high ($\underline{r} = .93$) and test-retest reliability after two weeks was also high ($\underline{r} = .86$). Alexander and Martray (1989) declared that the 25-item MARS was a "psychometrically equivalent alternative" to the 98-item MARS, while being more efficient, less costly, and easier to implement (p. 149).

The abbreviated MARS was administered to the control and treatment groups during the fifth week of class. A standardized set of instructions was read aloud by the instructors. Students were assured that their instructors would not have access to the individual MARS scores. The surveys were machine scored.

Precalculus Achievement. Six variables were used to measure student achievement in Precalculus. Included were four hourly exams, a final exam, and the final course percentage grade. The second, third, and fourth hourly exams included mostly new material with a few (20%) items testing material covered on earlier exams. The final exam was comprehensive. All exam items were written by members of the USAFA Department of Mathematical Sciences and the same exam was administered to all sections. Parallel make-up exams were administered to the few students who missed an exam. All exams were composed of multiple choice and open-ended items. The exams were reviewed by several mathematics instructors for content validity. Split-half reliability coefficients for all exams were calculated using the Spearman-Brown prophecy formula (Fraenkel & Wallen, 1993) and were found to be acceptable (coefficients ranged from .69 to .83).

As standard procedure at the Air Force Academy, exams were administered to the entire course population during the same period of time. Students were assigned to lecture halls and classrooms. Standardized directions were printed on the first page of the exams and read aloud by the instructors administering the exam. All students had identical time limits.

The four hourly exams were given from 7:00 to 7:50 a.m., before the start of classes. Students in both the treatment and control groups were permitted to use calculators on all four hourly exams.

The final exam was given seven days after the last class and was administered in two parts. Students were given 1 hour to complete Part I of the exam and 2 hours and 50 minutes to complete Part II. With the exception of five items, Part I was identical to the Algebra/Trigonometry Placement Exam. Part II was a cumulative exam containing mostly

anchored items. Students were not permitted to use calculators on Part I of the final exam. The use of calculators was permitted on Part II.

Multiple choice exam items for all exams were machine scored. Standardized rubrics were used to score open-ended items. In most cases, one instructor was assigned to score one item on all exam papers. For exam items that were scored by more than one instructor, a sample of 30 exams (15 from the treatment group and 15 from the control group) was selected for duplicate scoring. Inter-scorer reliability was calculated and found to be high (correlation coefficients ranged from .87 to .99). All exam scores were converted to percentages.

The final course percentage grade was based on the following sub-scores: (a) four hourly exams, 45%; (b) final exam, 30%; (c) three written exercises, 5%; (d) course project, 5%; (e) three group problem solving exercises, 5%; and (f) quiz, homework, and participation points awarded by the individual instructors, 10%.

Procedures. The experiment employed the ATI compensatory instructional model. The distributed practice treatment was designed to interact with the low prior achievement and high mathematics anxiety student aptitudes by circumventing or neutralizing their debilitating effects (Salomon, 1972). As recommended in previous ATI and homework research, the duration of the treatment was one semester, the entire duration of the Precalculus course (Austin, 1979; Becker, 1970; Becker & Young, 1978; Cronbach & Snow, 1977; Holtan, 1982; Koran & Koran, 1984; Snow, 1977).

Although assignment to Precalculus sections was not purely random, student course schedules at the USAFA are computer generated and students (especially first year students) have very few choices in their schedules. The treatment group consisted of approximately 46% of the Precalculus students (161 students divided into eight sections). The control group consisted of the remaining students enrolled in Precalculus (190 students divided into nine sections).

To minimize instructor workload, each instructor was assigned either all treatment sections or all control sections. The Precalculus sections were taught by eight different instructors; three instructors taught treatment group sections and five instructors taught control group sections.

All instructors were active duty members of the United States Air Force. Degree levels for instructors ranged from bachelor to doctoral with most instructors holding a master of science degree. Instructor experience level varied from first year instructors to a seasoned instructor with over 20 years teaching experience. Although most of the instructors had some prior teaching experience, few had prior experience teaching Precalculus. Both experienced and inexperienced instructors were assigned to each group in an attempt to equalize instructor experience across groups. When weighted by the number of sections, the mean instructor experience level for each group was 2.6 years. The median experience level was 2 years.

The course topics, textbook, handouts, reading assignments, and graded assignments (with the exception of quiz, homework, and participation points) were identical for the treatment and control groups. The listing of homework assignments in the syllabus differed between groups. The control group was assigned daily homework related to the topic(s) presented that day in class. Peterson (1971) calls this the vertical model for assigning mathematics homework. The treatment group was assigned homework in accordance with a distributed organizational pattern that combines practice on current topics and reinforcement of previously covered topics. Under the distributed model, approximately 40% of the problems on a given topic were assigned the day the topic was first introduced, with an

additional 20% assigned on the next lesson and the remaining 40% of problems on the topic assigned on subsequent lessons (Hirsch et al., 1983). In Hirsch's research and in this study, after the initial homework assignment, problem(s) representing a given topic resurfaced on the 2nd, 4th, 7th, 12th, and 21st lesson. Consequently, treatment group homework for lesson one consisted of only one topic; homework for lessons two and three consisted of two topics; and homework for lesson four through six consisted of three topics. This pattern continued as new topics were added and was applied to all non-exam, non-laboratory lessons.

The same homework problems were assigned to both groups with only the pattern of assignment differing. Because of the nature of the distributed practice model, homework for the treatment group contained fewer problems (relative to the control group) early in the semester with the number of problems increasing as the semester progressed. Later in the semester, homework for the treatment group contained more problems (relative to the control group). By the end of the semester, both groups had been assigned precisely the same homework problems.

Because homework was the key manipulated variable in this experiment, and because larger effects on achievement were sometimes found when homework was graded (Austin, 1979; Lai, 1994; Paschal, Weinstein, & Walberg, 1984), instructors were directed to collect all homework. Homework was checked and coded for correctness and completion on a three point scale (0 = less than one-third complete and correct, 1 = one-third to two-thirds complete and correct, and 2 = more than two-thirds complete and correct).

Instructors in both groups were encouraged to use class time to discuss and review the assigned homework problems. Prior to the second, third, and fourth exam, and at the end of the semester, both groups spent one lesson in review. Review lessons were planned by the individual instructors. Classroom observations and student and instructor surveys were used to ensure that the treatment was administered as planned and directed.

Results

The means and standard deviations for the entire sample and for the treatment and control groups on measures of prior achievement, mathematics anxiety, and Precalculus achievement are reported in Table 1.

Hierarchical multiple regression was employed to test the hypotheses[5]. Three sets of independent variables were defined. Set A, the covariate set, contained two variables: (a) prior math achievement, and (b) mathematics anxiety. Set B contained the group membership variable (treatment group or control group). Set C, the two-way interaction set, contained two interaction variables: (a) Prior Achievement × Treatment, and (b) Anxiety × Treatment. The dependent variable in this study was Precalculus achievement. Precalculus achievement was measured as the semester progressed and produced six scores: four hourly exam scores, a final exam score, and a final course percentage grade. By analyzing each measure of achievement separately, the goal was to determine whether the length of treatment had an impact on achievement with the expectation that the distributed practice treatment would have a cumulative effect (Austin, 1979).

[5] Multiple regression was selected as the analysis tool due to its ability to handle unequal cell sizes and quantitative independent variables (Cohen & Cohen, 1983).

Table 1. Descriptive statistics for measures of prior achievement, anxiety, and precalculus achievement. All prior achievement and achievement scores are measured in percent.

	Prior Achievement	Math anxiety	1st Exam	2nd Exam	3rd Exam	4th Exam	Final Exam	Course Grade
			All Students					
N	351	351	351	341	338	333	317	333
Mean	35.88	51.51	80.43	70.67	70.48	65.21	70.43	74.83
SD	8.74	14.44	13.25	13.67	13.10	13.55	11.13	8.55
Min	5.00	28.00	14.81	21.48	29.63	23.70	20.33	35.00
Max	50.00	99.00	99.26	96.30	100.00	100.00	94.67	96.76
			Treatment Group					
N	161	161	161	160	157	155	144	155
Mean	36.51	49.48	82.69	73.58	70.71	68.28	71.70	76.96
SD	8.09	12.96	11.89	12.79	12.99	12.73	10.60	7.84
Min	5.00	28.00	28.99	37.78	29.63	23.70	28.61	46.43
Max	50.00	93.00	99.26	95.56	98.52	100.00	93.56	94.83
			Control Group					
N	190	190	190	181	181	178	173	178
Mean	35.36	53.23	78.51	68.10	70.27	62.54	69.41	72.97
SD	9.24	15.42	14.05	13.93	13.23	13.71	11.48	8.72
min	5.00	28.00	14.81	21.48	30.37	28.15	20.33	35.00
max	47.50	99.00	99.26	96.30	100.00	99.26	94.67	96.76

Hypothesis Testing. Table 2 shows the results of the step-by-step hierarchical regressions as the three sets of independent variables were added.

Effect of the Covariates. Step one of the hierarchical multiple regression analyses tested the effect of the covariates (Set A, prior mathematics achievement and mathematics anxiety) on Precalculus achievement. Set A was regressed on each of the six measures of Precalculus achievement. A significant proportion of variance in all six measures of Precalculus achievement was explained by prior mathematics achievement and mathematics anxiety (see Table 2).

Main Treatment Effect. Step two of the hierarchical analyses tested for a main effect due to the distributed practice treatment. The covariates (Set A) and the group membership variable (Set B) were regressed on each of the six measures of Precalculus achievement. Tests of the semi-partial correlation coefficients revealed that, when the covariates were controlled for, the distributed practice treatment accounted for a statistically significant proportion of the variance in Precalculus achievement in all but the third exam and final exam (see Table 2).

Two-Way ATI Effects. Step three of the hierarchical regression analysis added the two aptitude-treatment interaction variables (Set C). The semi-partial correlation coefficients were tested to determine whether the interactions accounted for any variance in Precalculus achievement above what had already been accounted for by prior achievement, anxiety, and the distributed practice treatment. The effect of the two-way ATIs was not statistically significant for any of the six measures of Precalculus achievement (see Table 2).

Table 2. Hierarchical multiple regression analysis: main effect and interaction effect. Set A = placement test score and math anxiety score. Set B = group membership. Set C = two-way interactions. $*p < .05$ $**p < .01$ $***p < .001$

Independent variable sets	Cumulative R^2	df	F	Variable sets added	Increment to R^2	df	F of the increment
				First Exam			
A	.239	2, 348	54.66***	A			
A, B	.249			B	.010	1, 347	4.73*
A, B, C	.251			C	.001	2, 345	0.30
				Second Exam			
A	.169	2, 338	34.42***	A			
A, B	.193			B	.023	1, 337	9.78**
A, B, C	.198			C	.005	2, 335	1.07
				Third Exam			
A	.069	2, 335	12.46***	A			
A, B	.070			B	.000	1, 334	0.13
A, B, C	.073			C	.003	2, 332	0.56
				Fourth Exam			
A	.093	2, 330	16.97***	A			
A, B	.124			B	.031	1, 329	11.57**
A, B, C	.128			C	.004	2, 327	0.71
				Final Exam			
A	.121	2, 314	21.61***	A			
A, B	.125			B	.004	1,313	1.27
A, B, C	.126			C	.001	2,311	0.24
				Final Grade			
A	.203	2, 330	41.90***	A			
A, B	.234			B	.031	1, 329	13.48**
A, B, C	.236			C	.002	2, 327	0.36

Instructor Effects. Regression analysis was also used to determine whether there was a significant effect due to instructor after prior achievement, anxiety, and the treatment were controlled for. A two-step hierarchical regression was employed with the covariate and group membership variables (Set A') entered in the first step and the dummy-coded instructor variable set (Set B') added in the second step. Semi-partial correlation coefficients were calculated and F-tests were conducted. This analysis revealed that the instructors did not contribute to the variance in Precalculus achievement beyond what was already accounted for by prior achievement, anxiety, and the distributed practice treatment.

Study Time. The USAFA routinely collects study time data. After each exam, a large sample of cadets (at least 60% of the course population) anonymously reported the amount of time (in minutes) spent studying for the exam. Time spent studying was approximately equal for both groups (see Table 3). Descriptive data revels that, for both the treatment and control group, study time for the third exam was at least 16% greater than study time for any other exam. Study time for the final exam was at least 68% greater than study time for any of the

hourly exams (see Table 3).[6]

Table 3. Analysis of study times for exams. All p values > .20.

Exam	Treatment mean	Control mean	df	t
1st Exam	88.4 min.	84.5 min.	333	0.59
2nd Exam	95.4 min.	97.4 min.	296	0.23
3rd Exam	117.6 min.	116.9 min.	305	0.08
4th Exam	100.8 min.	93.2 min.	274	0.77
Final Exam	198.1 min.	235.9 min.	128	1.30

Effect of Homework on Exam Scores. Five separate regressions were performed to determine whether homework scores could predict a significant proportion of variance in exam scores. Block homework scores explained a statistically significant proportion of variance in all hourly exam scores. Similarly, the total homework score explained a statistically significant proportion of variance in the final exam score (see Table 4).

Table 4. Effect of homework on exam scores. ***$p < .001$

Exam	r	R^2	df	F
1st Exam	.39	.151	1, 349	62.07***
2nd Exam	.33	.109	1, 339	41.54***
3rd Exam	.33	.109	1, 336	41.22***
4th Exam	.30	.090	1, 331	32.67***
Final Exam	.39	.153	1, 315	56.96***

Discussion and Conclusions

Distributed Practice Effect. The distributed practice treatment produced a statistically significant main effect on four out of six measures of Precalculus achievement (three hourly exams and the final course percentage grade). These findings are in agreement with results reported by Friesen (1975), Parker (1990), Peterson (1970), Reed (1983; Klingele & Reed, 1984), and Saxon (1982). The treatment did not produce a statistically significant main effect on the third exam or final exam.

Effect sizes were calculated to better interpret the practical significance of the distributed practice treatment. The treatment produced an effect size (f^2) of 0.013 on the first exam, 0.029 on the second exam, 0.035 on the fourth exam, and 0.040 on the final course percentage grade. Although the effect sizes appear to be small, the treatment group outscored the control group in every case. A mean difference of 5.13 percentage points on the first, second, and fourth exam translates to an advantage of about a third of a letter grade for students in the treatment group. In addition, higher minimum scores earned by the treatment group may indicate that the distributed practice treatment served to eliminate the extremely low scores (refer to Table 3). As postulated by Austin (1979), the distributive practice

[6] Since the group of students sampled for study time for one exam was not necessarily independent of the group of students sampled for study time for other exams, inferential statistical tests of study times between exams are not appropriate.

treatment appeared to have a cumulative effect.

Because the distributed practice treatment produced a significant main effect on all but one of the hourly exams, a plausible explanation for this aberration was sought. The treatment and control groups achieved nearly equal scores on the third exam (treatment mean = 70.71 and control mean = 70.27). Although the two groups spent nearly equal time studying for the exam (treatment mean = 117.6 minutes and control mean = 116.9 minutes), both groups reported spending much more time studying for the third exam than they spent studying for any of the other three hourly exams. The third exam occurred after mid-semester progress reports which may have motivated students to devote more time to studying. It is possible that the additional study time imitated the distributed practice treatment by allowing for more repetitions of problem types.

Oddly, the distributed practice treatment did not produce a significant effect on final exam scores. One possible cause for the disparity was the USAFA policy exempting the top performers from the final exam. Of the 16 exempted students, 11 were from the treatment group with only 5 from the control group. It is likely that the treatment group would have outscored the control group on the final exam if these top performers had taken the exam. In addition, increased study time for the final exam may have influenced the results. Because the final exam was scheduled late during final exam week, study time for the exam was not only longer, but more widely distributed. The benefits of the longer and more dispersed study time may have been similar to the benefits created by the distributed practice treatment.

Aptitude-Treatment Interaction Effects. Two significant two-way interactions were expected: (a) Prior Mathematics Achievement × Treatment, and (b) Mathematics Anxiety × Treatment. Neither of these interactions was found to explain a significant proportion of variance in Precalculus achievement beyond what had already been explained by the covariates and the distributed practice treatment.

The sample in this study, first year students on the low mathematics ability track at the Air Force Academy, may provide some explanation for the lack of significant interaction effects. Students on the average track are typically enrolled in Calculus I during the Fall semester and Calculus II during the Spring semester. Similarly, those with high math ability are usually enrolled in Calculus II or Calculus III during the Fall semester. Because mathematics achievement has been found to correlate negatively with mathematics anxiety (Berenson, Carter, & Norwood, 1992; Clute, 1984; Coleman, 1991; Cooper & Robinson, 1989; Covington & Omelich, 1987; Frary & Ling, 1983; Gliner, 1987; Hembree, 1990; Lawson, 1993; McCoy, 1992; Richardson & Suinn, 1972), the students placed into Precalculus were probably relatively high in mathematics anxiety. Aptitude-treatment interactions are not expected to be as strong when students have comparable aptitudes. The homogeneity of this group may have nullified the expected two-way interaction effects.

The results of this study challenge the results reported by Hirsch and his colleagues (1982, 1983). Hirsch et al. found significant Prior Achievement × Treatment ATIs on three out of five measures of Calculus I achievement. In all three cases, the distributed practice treatment was beneficial to students scoring at or below the mean on an algebra and analytic geometry pre-test. It is not known whether the students in Hirsch's study were grouped homogeneously.

Limitations. This study was limited by the length of the semester and the number of homework assignments. By following the homework pattern advocated by Hirsch et al. (1982, 1983), homework for topics introduced after the tenth lesson could not be fully

distributed. Homework for each topic was assigned in the order listed in the textbook, in which the easier problems preceded the more difficult ones. For the treatment group, this meant that the easiest problems were assigned early in the distribution pattern with the hardest problems assigned in the later stages of the distribution. The treatment may have been more effective if the difficulty level of problems within each assignment was mixed. Similarly, the distributed practice treatment may be more effective when applied to courses of longer duration.

Several factors may limit the generalizability of this study. Although the sample was large, the subjects, being military academy cadets, may not be representative of typical high school or college students. Overall, students attending the USAFA are a fairly homogeneous group with similar academic and career goals. The limited external validity due to the controlled atmosphere at the Air Force Academy serves to strengthen the internal validity of the study. Threats due to subject characteristics, mortality, location, history, and subject attitude have been minimized due to the controlled environment at the USAFA (Fraenkel & Wallen, 1993).

Certain threats to internal validity remain. Although it cannot be assumed that instructors with similar experience levels are equally effective, this study and a previous study conducted at the USAFA found that instructor experience was not a significant contributor to achievement variance (Thompson, Mitchell, Coffin, & Hassett, 1979). It is possible that one or more instructors were biased, either for or against the distributed practice treatment. A Hawthorne effect may have resulted if the students in the treatment group recognized that they were receiving special treatment in the way of distributed practice homework assignments (Fraenkel & Wallen, 1993). Conversely, students assigned to the control group may have suffered a demoralization effect (Fraenkel & Wallen). In addition, the treatment may have had a negative impact on the achievement of the treatment group if exam items were related to homework problems not yet assigned due to the distributed practice syllabus. Finally, it is possible that the treatment was not fully confined to the treatment group. Although survey responses indicated that students rarely studied with students who used a different syllabus, it is possible that cadets discussed homework problems with students from other sections.

Recommendations for Future Research. Distributed practice homework has been shown to be beneficial to students on the low mathematics track at the USAFA. Testing of the distributed practice treatment on medium and high ability students is recommended. In addition, different variations of spaced review should be investigated across a wide variety of students, institutions, and mathematics courses. Because the collection and grading of homework may have caused a higher than average homework completion rate, this study should be replicated in an environment where homework is not collected.

Future studies of this kind should include the study time variable. The study time data in this experiment indicate that the distributed practice treatment had the greatest impact when less time was devoted to studying for an exam. This finding appears to support the theory that distributed practice assignments receive more attention than massed assignments. An analysis of how students use their study time could help shed light on why and how this phenomenon occurs.

According to Holtan (1982), the value of the distributed practice treatment may well be in the delayed retention of the skills and concepts practiced. Follow-up retention tests are recommended for the students taking part in this study.

The multiple correlations revealed in this study accounted for less than 26% of the variance in all measures of achievement. This suggests that the contribution of other variables such as motivation, attitude, and study habits should be examined. Systematic research in this area should help identify the students who will benefit most from distributed practice assignments and contribute to the theoretical structure of ATI.

Summary

This study documented a significant positive correlation between homework scores and exam scores. Homework scores were found to account for between 10% and 15% of the variability in exam scores. Meaningful homework may be viewed as an important component in mastering mathematics course material.

Enrollments in remedial mathematics college courses are on the rise (Berenson et al., 1992) and 90% of college mathematics enrollments are in elementary calculus, elementary statistics, and courses prerequisite to them (National Research Council, 1989). There is great potential for application of the distributed practice model. Mathematics achievement is still the principal gateway for students preparing to enter technical and scientific careers, and distributed practice may help foster success in these pivotal math courses.

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In-Class Exercises for Active Learning and Beyond

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Abstract: The In-Class Exercise has gained wide acceptance in the US Air Force Academy Department of Electrical Engineering as a tool through which active learning can be achieved in the classroom. After some years of use, it has become clear that the utility of these exercises extends well beyond their original intent. Important windfall benefits have been realized in course development, evaluation, instructional efficiency and development of new instructors. We feel their advantages make them worthy of careful consideration by teaching professionals of all disciplines.

No one need remind a USAF Academy (USAFA) faculty member of the diversity of activities in which their students engage themselves. In a typical semester, instructors have face-to-face contact with their cadet students less than 2% of their waking hours[7]. It is therefore exceedingly important that we maximize the effectiveness of those precious minutes of classroom instruction. We, in the Department of Electrical Engineering (DFEE), have found the In-Class Exercise (ICEx) to be an important tool for improving instructional effectiveness. Over one-third of our active classroom courses (versus laboratory or design courses) use these exercises, including DFEE's core course[8], El Engr 215. Originally intended as a method to invoke active learning processes, these exercises have evolved into much more. Through years of use it has become clear how these exercises also affect our organization of course materials, our choice of course content, the evaluation our students, and the development of new instructors. We have come to recognize their value, not only as aids to teaching, but to teacher effectiveness as well.

The In-Class Exercise: What and Why

Although the exact nature of these exercises varies from course to course, our In-Class Exercises have evolved into a fairly consistent form. Naturally, our ICExs are delivered in an active learning classroom environment. The content of each exercise is chosen to highlight key concepts or principles under consideration. These exercises are generally adapted from problems or examples found in the course text or materials. They are limited in scope so they may be completed within a single class period, ideally in less than twenty minutes. Most are delivered on a single page. All exercises are accompanied by printed solutions released after completion of the exercise. Each exercise requires a written response from every student. An example of one such In-Class Exercise is found in Appendix A.

There are a few basic reasons for the form into which ICExs have evolved. Their fundamental purpose is to draw cadets into an active role in the classroom and to engage them with key concepts or processes. Their content is selected so that a strong pedagogical tie is made with other course resources. In this way ICExs serve as introductions or reinforcements to the more detailed discussion provided by the text or course materials. We also believe the

[7] This estimate assumes six eighteen-hour days per week and one 50-minute section two and one-half times during that week. This is the normal USAFA instructional cycle.
[8] The USAFA curriculum contains some 112 semester hours of essential or "core" courses required of all cadets for graduation. These courses have enrollments of some 1,000 cadets each academic year.

exercises must be brief enough to capture and hold the attention of our cadets. The single page format is helpful in bounding the complexity of the exercises and preventing them from appearing too overwhelming. We also favor the distribution of printed solutions to our ICExs as a method to reinforce concepts and reassure students. The solutions also offer instructors a method to highlight issues not central to the focus of the exercise, but which are easily illustrated in the framework of the exercise.

We have come to favor the written format for ICExs for five reasons. First, it creates a permanent record of each student's work that may be both evaluated by the instructor and reviewed by the student. Second, written responses eliminate the potential for the embarrassment inherent in exercises worked at the blackboard. Third, the graphics delivered with the ICExs streamline classroom interactions. There is no need to re-copy equations, figures or graphs from a blackboard or transparency. Cadets are free to focus instead upon the problem or concept at hand. Fourth, the written exercises afford those cadets who might miss a class meeting a snapshot of that lesson's key concepts. Finally, the written ICExs form a permanent conceptual record that can be referred to later in a course, or in a follow-on course.

Although it does not occur universally, we have observed an additional, unintended benefit of written ICExs. In many cases, our cadets extend the written responses required for the ICExs into class notes (See Appendix A). We see many exercises where cadets will record related concepts from the lecture, which are not parts of the exercise. They, in effect, use the exercises as note taking aids. Considering the framework the exercises provide, these notes are often more accurate and meaningful to students than those they generate individually.

A few variations in the delivery of these exercises are common in our department. Some courses award grade credit for these exercises, others do not. Some exercises are run with full student-to-student collaboration where the instructor's discussion of the exercise is limited. Others are worked interactively with students selected by the instructor, with the balance of the class as witnesses.

The In-Class Exercise: Are They Beneficial?

Both survey data and anecdotal evidence indicate the positive perceived benefit of these exercises. A recently completed study of teaching methodologies reveals a strong cadet preference for ICExs (Soda, 1999). All cadets surveyed in El Engr 341 last semester rated the In-Class Exercise as the most beneficial of the teaching methods used in this course. This ICExs were preferred over lecture, homework, and personal study from the course text or outside references. While the motivations for this preference varied, course critiques reveal a strong perceived utility as guides for test preparation. The opportunity to work an exercise with some measure of instructor guidance is another common motivation. Instant feedback relative to common misconceptions in a relatively low threat framework is yet another.

One might well wonder if this perceived benefit is unique to the USAFA teaching environment. The aforementioned study includes survey data taken from students in a similar course taught at Colorado Technical University (CTU). While not nearly as uniform in their responses, the primarily part-time students at CTU felt ICExs were at least as beneficial to learning as lecture, homework and self-study. We believe ICExs hold inherent benefit even in teaching environments comprised primarily of part-time students.

In-Class Exercises: What Other Benefits?

While the ICEx is a powerful classroom teaching tool, we have also come to appreciate their usefulness from our perspective as faculty members. After some years of use, we have come to realize their merit as guides in the selection of course content; as a basis for setting realistic limits on classroom discussion; as natural transitions to other course exercises; as methods to express alternative explanations; as conduits of course materials to new instructors; and as guides in our evaluation processes.

Our challenge, indeed that of all teachers, is to identify, communicate, illustrate, amplify and instill the most important concepts and relationships of the material at hand. None of us has the time to teach all the concepts we would like, hence, identifying the most important ones is a key process. Since ICExs, by their nature, focus upon these very concepts, we have found their development a convenient process through which we may solidify our topical choices for classroom presentation. They also serve as a global summary of our choices. A collection of ten or twelve ICExs laid side-by-side, can more succinctly illustrate the flow of a block of instruction than can an equal number of lesson plans.

As long as we are true to the principle of exercise completion during a single class meeting, we are also forced to carefully limit the content of each lesson. As we develop new exercises, we must constantly come to grips with the teacher's dilemma: what will and won't we have the time resource to cover.

When properly chosen, ICExs can act as springboards to the more intricate and interrelated concepts illustrated in homework, computer simulations and laboratory exercises. By clarifying the basics, our instructors use them to build links to other kinds of out-of-class work. Consider the computer based circuit simulation projects which are common in our department. ICExs can serve as illustrations of the operation of a basic circuit, which is then expanded out of class into a more complex circuit in the computer simulation. We find this kind of transition useful in clarifying circuit behavior and setting proper expectations for the outcome of the computer exercise.

Experienced teachers often develop their own alternative explanations for troubling concepts. In-Class Exercises can act as a convenient technique for recording and expressing these alternative explanations in a fashion which is familiar to students. In a sense, these exercises become the method through which teachers can modify the thought process laid down by the course text where the content or examples have fallen below expectations.

There are probably few post secondary educational institutions that have a more dynamic faculty staffing environment than does USAFA. Perhaps as many as one third of the military faculty members are transferred back to operational assignments each academic year. With this situation in mind, we have found the ICEx as a conduit by which detailed course materials can be passed from experienced to new instructors. While all teachers improve their instructional quality over time, our new faculty find ICExs particularly useful when preparing to teach a new course. Since they serve as models of instructional techniques, these ICExs also serve as guides to new faculty working to develop their own course materials.

An often-overlooked merit of the In-Class Exercises is their contribution to the evaluation process. When choosing topics for test purposes, the current ICExs can again serve as an important organizational tool. While our test questions are virtually never identical to ICExs, we find them a convenient summary of the current field of topics and principles. In this framework, we can easily identify those problems which clearly fall outside of the scope of the current block of instruction. Aside from the topical selection process, ICExs also serve

as a reminder of the solution methods and processes most heavily emphasized. We have found our selection of problems, and their level of difficulty, to be greatly enhanced by a review of these instructional tools.

In-Class Exercises: At What Cost?

No instructional process comes without cost. ICExs are not free by any means. Development of these exercises requires preparation extending beyond conventional lesson planning. Layout, proofreading, development of solutions and reproduction time must all be taken into account. In those courses where ICExs are awarded course credit, grading is added to the burden of instruction. The effort these exercises demanded of instructors must be repeated each time the companion text or software is modified or updated. The level of effort required to update can affect, perhaps inappropriately, decisions to adopt new course materials.

Summary

In-Class Exercises offer a host of advantages to our students: motivation to be on task, thoughtful topical summaries, and instant feedback. At the same time, these exercises also hold significant advantages for faculty; guidance in the selection of course content; a basis for limiting classroom discussion; springboards to other course work; a conduit for alternative explanations; a legacy for new faculty to consider; and guidance for course and test planning. In a world where the quantity of knowledge doubles every few years, educators must carefully choose not only what to teach, but how to teach. While they demand effort to develop, present and evaluate, we feel In-Class Exercises merit the thoughtful consideration of teaching professionals of all disciplines.

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Appendix A – Example ICEx

An example of a completed In-Class Exercise is shown below. This particular exercise is taken from the first block of instruction of El Engr 342, Electronics II and is used to help introduce the concept of differential pair amplifiers. The cadet completing this particular exercise added notes derived from the classroom discussion occurring both before and after the exercise was administered. These notes fall outside the normal scope of this exercise and represent an unintended of their use (see text).

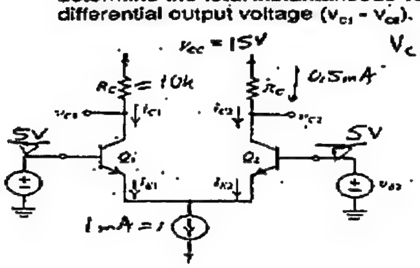
Name:

El Engr 342 - In Class Exercise:

Collaboration Policy: You may work with assigned cadets in the completion of this exercise.

Documentation: In class discussion.

Lesson 2: Part A. Consider the differential amplifier shown below. If I = 1mA, V_{CC} = 15V, R_C = 10 K, α = 1, v_{B1} = 5 + 0.005 sin wt and v_{B2} = 5 - 0.005 sin wt determine the total instantaneous value of both collector voltages and the differential output voltage ($v_{c1} - v_{c2}$). ↑ trans conductance: ↑ I or ↑ R_1, R_2



$V_C > V_B > V_E$: Active Mode.

$V_B = 5V$

$V_E = 4.3V$

$V_{c_1} = 15V - 5V = 10V$

(0.5mA)(10k)

$V_{c_2} = 10V$

$V_{c_1} = V_{cc} > V_{B_1} \times V_{B_2} > V_E$'s.

$A_d = -g_m R_c = \frac{v_{c_1} - v_{c_2}}{v_d}$

$v_d = 10mV \sin\omega t \; (v_{b_2} - v_{b_1})$

$A_d = -\frac{\alpha I}{2V_T} \cdot R_c = \frac{-1(1mA)}{(2)(0.025mV)} \cdot 10k$

$= -200 \frac{V}{V} \Big\}$ gain

$v_{c_1} - v_{c_2} = A_d \cdot v_d$

$= -200 \; (10mV \sin\omega t)$

$v_{c_1} - v_{c_2} = v_o = -2.0V \sin\omega t$

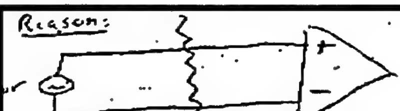
Total Quantities : Only amplifies voltage differences.

$V_{c_1} = 10 - 1 \sin\omega t$

$V_{c_2} = 10 + 1 \sin\omega t$

$\Delta V_x = -2 \sin\omega t$

Reason:



Differential Pair Amplifier ignores common mode voltages.

Amplify difference voltages only.

Exercise Solution

Spring 1996

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INFORMATION TECHNOLOGY

Economics Electronic Workbook and Online Experiments (Workshop)

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Abstract: This project develops and disseminates instructional software architecture that will integrate empirical investigation and the experimental method into the undergraduate economics curriculum. Users of the software, which will be available over the internet, will be able to add a regular lab component to their introductory and intermediate-level courses in economics. The laboratory modules will be powered by Microsoft Backoffice and Imprise Delphi, and allow faculty to easily add customizing features, such as graphic and online quizzes.

This project develops and disseminates instructional software architecture that will serve to integrate empirical investigation and the experimental method into the undergraduate economics curriculum. Users of the software, which will be available over the internet, will be able to add a regular laboratory component to their introductory and intermediate-level courses in economics. The laboratory modules, while complete in themselves, will be structured in a computer technology that allows faculty to easily add customizing features, such as lecture notes and graphic images. This will represent the first extensive use of the Microsoft Backoffice in the economics curriculum. Web pages use a SQL Server database to generate real time graded question and answer sequences, with responses stored in and disseminated from the database. The goal of the proposed project is to bridge the theoretical and empirical aspects of economics early on in the student's academic career. The means of achieving this goal is the provision of computer technology that makes the best interactive and accessibility features of the internet available to faculty, regardless of their programming knowledge. The results of the project will reach non-economics majors who take introductory courses in the field, as well as those majoring in the field. Future work using this architecture could extend to all levels of the undergraduate major, where laboratory modules will give students a better feel for working with economic data and for the ability of the experimental method to reveal the basic workings of the market mechanism. Assessment of the benefits of using this technology will be done by creating an assessment test administered pre- and post-instruction to both a group using the technology and a control group. Electronic auctions developed may enhance acquisition efficiencies in the Department of Defense.

The workshop demonstrated how student users interact with the workbook, how instructors access and use student performance reports, and how content authors can make changes. In addition there was an overview description of the software architecture of the workbook and of one online economics experiment. Finally, there was a discussion of the plans of future development and assessment methodology.

Just-in-Time Teaching (Workshop)

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Department of Physics

Abstract: In this workshop we provided a hands-on tutorial on Just-in-Time Teaching (JiTT), a web-based pedagogy pioneered as a collaborative effort of physics faculty at USAFA and at Indiana University-Purdue University Indianapolis (an urban campus serving 27,000 students). JiTT pedagogy exploits an interaction between web-based study and an active learner classroom. Assignments and enrichment materials are delivered to the students over the web. Students respond to these assignments electronically. These student submissions provide immediate feedback to the instructors concerning the state of the class' progress. These assignments, due in the morning a few hours before class, are used to adjust the lesson content and activities to suit the students' needs. During the past two years we have presented these techniques at 24 invited workshops, five of them to non-physics audiences. The sponsor organizations range from the American Association of Physics Teachers to Project Kaleidoscope and the National Science Foundation. Educators at more than a dozen schools are currently experimenting with this pedagogy at institutions ranging from Harvard University to the University of Illinois at Urbana to The Nightingale-Bamford School in Manhattan. A short paper detailing the essence of JiTT can be found at http://webphysics.iupui.edu/JITT/ccjitt.html

Workshop Audience

The intended workshop audience was faculty currently using an active learner approach to teaching. The workshop was also geared toward faculty who are interested in learning about the various ways the web can be used in instruction and who are contemplating adopting or adapting some of these innovative approaches to teaching. No special skills on the part of the workshop participants were assumed, and no technical expertise was required.

Workshop Resources

The workshop was held in the USAFA Network Classroom Lab (NCL), where each participant had individual access to a computer workstation. The workstations each had internet connections. The workshop had its own World Wide Web homepage at http://www.usafa.af.mil/dfp/physics/webphysics/usafajitt/

Workshop Activities

1. Participants were asked to complete a "preflight" as preparation for workshop involvement.
2. A presentation and exploration of Just-in-Time Teaching (JiTT) materials developed for our introductory physics classes. Rather than the content, we emphasized the structure of these documents and the rationale behind their development, focusing on their relation to classroom instruction. Thus workshop participants contemplated how these resources could be adapted to their own disciplines.
3. A session on JiTT pedagogy (including the management of an active learner classroom.)
4. Exploration and application of JiTT templates, including exploratory visits to resource sites for selected other disciplines. Workshop participants were encouraged to look at these materials with a creatively open mind and imagine how these resources would enrich their own teaching initiatives.
5. A discussion of implementation details and technology issues.

Workshop Deliverables

1. JiTT HTML templates and information about the DFP "Preflight Editor" that is used to author, deliver, and record student responses to preflights.
2. A JiTT handout comprised of selected excerpts from the *Just-in-Time Teaching: Blending Active Learning with Web Technology* book (authors G. Novak, E. Patterson, A. Gavrin, and W. Christian) to be published in March of 1999 by Prentice Hall.
3. The workshop resources remain available at the workshop website, http://www.usafa.af.mil/dfp/physics/webphysics/usafajitt/

Description of JiTT Pedagogy

Since its inception in 1995, the World Wide Web technology has been widely adopted for teaching purposes. Web sites serve as communication hubs for student-teacher, student-student and teacher-teacher interactions. Web-based instructional material can structure the out-of-the-classroom time so the students can use it more productively. The Just-in-Time Teaching approach blends an active learner classroom with the around-the-clock communication capability of the World Wide Web. Students interact with one another, human instructors, and technology in ways that optimize the effectiveness of these interactions. While no technology can match the benefits of an expert human mentor who observes the learning activity and intervenes as needed, there are aspects of learning where technology can have an edge over a human instructor.

Just-in-Time Teaching (JiTT) is a teaching and learning strategy comprised of two elements: classroom activities that promote active learning and World Wide Web resources that are used to enhance the classroom component. Many industries use Just-in-Time methods that combine high-speed communications and rapid distribution systems to improve efficiency and flexibility. Our use of JiTT is analogous in many ways. We combine high-speed communications on the web with our ability to rapidly adjust content. This makes our classroom activities more efficient and more closely tuned to our students' needs. The essential element of JiTT is feedback between the web-based and classroom activities.

The JiTT web materials fall into several broad categories: electronic preparatory assignments, enrichment extra credit materials, online homework, and information and communication. The heart of the JiTT strategy is in the use of the electronic preparatory assignments, of which there are two types: the WarmUp/Preflight and the Puzzle. These assignments provide an introduction and a conclusion to a given topic, as described briefly below.

The WarmUp/Preflight and Puzzle web assignments share a common set of characteristics:

- The questions asked are motivated by a clear set of learning objectives
- The web assignments introduce students to the technical terms.
- The questions require students to confront their previously held notions.
- The questions are extendible.

JiTT classroom lessons are built around student answers to "Preflights" (called "WarmUps" at most institutions other than USAFA). Preflights are web-based preparatory assignments that are due a few hours before class. The students complete these assignments individually, at their own pace, and submit them electronically. The instructor collects the students' electronic submissions, reads them, and adjusts and organizes the classroom lessons

in response to the student submissions "Just-in-Time." With this strategy, the instructor learns what the students already understand, what they find difficult, and where their confusion is, before ever beginning class. Typically, during the lesson, the instructor presents a selected (anonymous) subset of the student responses to the class, weaving them into the class as appropriate. This establishes a feedback loop between the classroom and the web that is beneficial to students and instructors alike. Students in the classroom recognize their own wording, both correct and incorrect, and thus become engaged as part of the feedback loop. Discreet in-class critique of their submissions helps improve the writing skills and the construction of physics knowledge. It is quite common for the classroom discussion to continue via email between the instructor and particular students. Paradoxically, technology used this way encourages a more personal and intimate bond between instructors and students. It is clear from course evaluations that students feel part of a team working on a common project.

We have several basic objectives in constructing a Preflight assignment:

- Set the framework for the physics to be studied in practical everyday terms.
- Pique the student's curiosity; generate a need to know.
- Relate material to be learned to material already studied.
- Give the student a sense of confidence.

Having done the assignment, the student should be able to say, "I know what the lesson will be about. I understand the scenario and I understand the question. I have some idea of the answer but I am not sure and I don't know all the details."

To accomplish the above objectives we present each question in a context that can be understood without reading the textbook. However, the question should incorporate the important concepts from the chapter. We typically present a scenario and with one or more questions ask the student to predict the outcome. It is important that the question be simple and straightforward so that the student has no trouble understanding what is being asked. It is equally important that the question be complex enough so that some conceptual understanding of physics is necessary to provide a complete answer. When the underlying physics contains frequently held erroneous preconceptions, the Preflight question is constructed so as to flush out these preconceptions. The classroom discussion of such questions must be explicit enough to persuade the students to give up the preconceived notions. It may well be necessary to bolster the case with a well-planned demonstration or activity. Where possible, we leave some particulars out, to be supplied by the student. This adds variety, which makes the classroom discussion more interesting.

It is important to make the questions good discussion starters. It is not uncommon for students in JiTT courses to be talking about Preflight questions in their conversations before class begins. The best Preflight questions engage the students enough that they are actually thinking about the questions and their answers prior to class. Good questions fall into different categories but generally share one or more of the following features.

- are attention catchers
- refer to current events
- are just ambiguous enough to cause the students to really pause and think
- explicitly confront problem areas identified by physics education research
- pick up on a thread from a very recent class discussion or activity
- are not too easy or too hard
- include at least some (preferably all) nontechnical phrasing

Another feature that often works well to generate discussion and facilitate understanding deals with multiple choice questions. We sometimes include more than one choice that could be correct, depending on the assumptions the student makes about the setup. These questions then are deliberately ambiguous or loosely defined. It is not a good idea to have this kind of question unless the students are explicitly told that "there may be no one correct answer to this" and that "the purpose of this question is to elicit discussion in class." Furthermore, students should not be awarded course points based on correctness in such cases of deliberately vague or ambiguous problems, for they can easily become disheartened. The students should not feel that they are being penalized for having been "tricked", but rather should feel that the question has brought about a "teachable moment" that has helped them to solidify their understanding.

Helping students recognize that their "everyday" understanding of words and ideas may be incorrect or incomplete is a crucial part of the learning process. Furthermore, reminding them to reconsider and reflect on actual experiences they may have had, and asking them to confront their preconceived ideas about the way nature works, helps students to construct new and deeper reasoning and understanding [Fuller, 1982]. In fact, this idea is central to the Learning Cycle, a teaching strategy developed by physicist Robert Karplus [Karplus, 1977]. The JiTT web component helps students consider their everyday understanding and experiences, realize that their current mental constructs are incomplete, and come prepared to deal with them in the classroom where they are guided by the instructor.

The other preparatory web assignment is the Puzzle. We think of the Preflight and Puzzle activities loosely as bookends for a given topic, with the Preflight beginning and the Puzzle concluding. Since the puzzle ends a topic, it is subtler, and usually requires integration of many ideas. Each week we assign one Puzzle. Typically, it is a single question that may be somewhat vague and involves several concepts. As the name implies, the puzzle is a physics scenario with an extra twist that requires the student to see beyond the end-of-chapter formulas. This is often accomplished by further challenging commonly held misconceptions. The Hestenes Force Concept Inventory questions [Halloun and Hestenes, 1985] and Eric Mazur's peer instruction questions [Mazur, 1996] have a similar character. These questions may appear trivial to a physicist, and many can be answered without calculations. On the other hand, they usually present a significant challenge to the beginning student. In the classroom, we use the Puzzles much as we do the Preflights. Based on excerpts from the students' solutions, we lead a classroom discussion of the question and of possible variations and extensions. This lends itself well to closing a topic and then integrating it with the rest of the course material. Since the Puzzle closes the topic, we expect greater precision in the answers, and we evaluate Puzzle answers more rigorously. Answers should be technically correct and well stated.

In addition to the Preflight/WarmUp and puzzle pages, there is a weekly applications page that features an essay on some topic, related but not central to the course material. In our physics classes this page is titled, "What's Physics Good For?" These essays differ from the "application" essays in textbooks in important ways. First, they contain numerous links to external web sites containing a wealth of related material. Second, they always end with extra credit assignments, which induce the students to follow the web links and thus relate the course material to the real world.

Our JiTT courses also offer information and communication pages that contain the electronic edition of traditional handout material such as the syllabus and the course calendar as well as the electronic version of the course bulletin board.

The JiTT web material is designed to facilitate an effective blend of human and technological resources. The web assignments encourage students to prepare for the classroom activity where the instructors will provide the intellectual mentoring. The key to JiTT is to use web communication technology to prepare both the students and the instructors for the events in the classroom. Working with the JiTT strategy has convinced us that the web, combined with live teachers in the classroom, can personalize instruction for all students and make a real difference to the non-traditional student.

More information about JiTT is available via the JiTT website, http://webphysics.iupui.edu/jitt.htm, and will be available shortly through the *Just-in-Time Teaching: Blending Active Learning with Web Technology* book to be published by Prentice Hall in March 1999.

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IT in the Classroom; Should We Throw Away the Chalk? (Panel)

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Panel Members: Dr. Evelyn Patterson (Dept of Physics), Maj Glenn Hover (Dept of Behavioral Sciences and Leadership)

Abstract: Academicians are both attracted to and repelled by the thought of using information technology (IT) as a teaching tool. Information technology can be used to enhance classroom presentation and to expand the classroom beyond traditional time and space limitations. In addition, interactive study guides delivered via the WWW can provide a mechanism for instantaneous feedback to the student on their progress. However, using technology can also limit spontaneity and become the focus of the classroom experience, rather than a teaching tool. Therefore, the purpose of this panel is to discuss the advantages and disadvantages of using technology in the classroom, and to discuss when and if it is appropriate to "throw away the chalk".

Academicians are both attracted to and repelled by the thought of using information technology (IT) as a teaching tool. The attraction is the value of being able to communicate and discuss ideas to a virtually unlimited number of people in a greater variety of ways without geographical and time barriers. The repellant is that technology will prove the undoing of academics. It has been argued that technology uses up large amounts of time and money producing "canned" presentations and that multimedia presentations make the printed page look boring. It has also been argued that multimedia presentations suppress the imagination, and promote the decline in literacy by favoring video over pictures, and pictures over words. In this panel, we discussed some advantages and disadvantages of using technology as a teaching tool.

There are many benefits of using technology to enhance the classroom learning environment. Within the classroom, colorful visual presentations prepared using presentation development software (e.g. PowerPoint), can be used to provide concise outlines for students that break down difficult concepts into smaller and more conceptually manageable ones. Computer-generated animation sequences often show processes that are difficult to conceptualize better than static textbook images can display them. In addition, document cameras and similar projection devices can project instructor demonstrations on a screen for easier viewing by the class. Images projected from a microscope, for example, are easier for a group to view when projected than when students take turns looking through the ocular lens. These images can often be photographed and/or stored on disc for later reference.

The use of information technology can expand the classroom. Posting assignments and course material on the internet allows students to access information anywhere and at anytime, which provides flexibility for busy students and possibilities for making up missed classes. Class materials can be linked to other resources from other departments and institutions, which gives interested students the opportunity to further explore a given topic. Video clips and animations that are used in the classroom can also be made available for students to review outside of class by posting them to a website.

Online multimedia study guides can be designed to address different learning styles and provide a mechanism for interactive assignments and instantaneous feedback. Numerous studies have shown that most students retain more information when they engage in active,

rather than passive, learning strategies. In addition, online practice exams give students immediate feedback on their performance and their level of understanding the information. An individual student's performance can be automatically tracked by the instructor and can be used to assess which students might require extra help outside of class. Tracking can also be anonymous, which may decrease the student's embarrassment over poor performance and encourage participation while still making the instructor aware of difficult concepts and important stumbling blocks by the class as a whole.

Videoteleconferencing is another type of technology that can expand the classroom by providing a mechanism for guest speakers to give lectures from remote sites thousands of miles away. This is beneficial when the guest lecturer lacks the time and or resources to travel. While this scenario is not superior to the personal interactions that can be achieved by an in-class visit, it does open up new possibilities for interactions that otherwise might not take place.

However, the use of technology in teaching is not a universal panacea, and can create difficulties. Highly polished PowerPoint presentations may look nice, but the instructor risks "scripting the class" which is not always compatible with Socratic dialog. The instructor may feel compelled to stick to their fine tuned outline and not allow deviations from their outline in response to questions. In addition, these presentations are often delivered with the lights turned low, and giving out copies of the slides may encourage students to daydream during class since they know they will get the material in a hand out.

Easy access to more information from the internet doesn't mean receiving better information. The instructor needs to provide guidance to the students as they access outside resources. Currently, there are no standards or a peer-review process for website content. The easy access to good quality websites with valid content is therefore diluted by the plethora of poor quality websites with questionable content, and students may have difficulty in determining the quality and validity of these resources.

Another problem with using technology is over reliance on that technology. The WWW may be inferior to traditional textbooks for reading assignments. People seem to be more comfortable reading text from a book, than off of a computer screen. In addition, when students are assigned to readings from a text, they generally know in advance the length of the reading. Simply giving students the website address does not convey that information, which may cause them to underestimate the time required to complete an assignment and contribute to them being unprepared for class or an examination.

Once you rely on technology to accomplish a task, the technology must continue to work. Problems as small as printer jams and burned out light bulbs can ruin even the best prepared lesson. Larger problems such an unstable network can interfere with students' ability to access their assignments, or turn in homework. This will lead to frustration and can act as an impediment, rather than an enhancement to learning. People generally must be able to successfully access a system 90 - 95% of the time to have confidence in its reliability and to continue to access the system. Since most internet systems rely on a system of servers and routers, instability of one part of the system can have exponential negative effects.

Therefore, technology should be used judiciously. The advantages and disadvantages of using technology in teaching should be balanced against each other. It is also important to remember that there are two different users – one who is teaching and the other who is learning, and they often have different interface and design needs. However, used properly,

technology is one more tool to be added to the mix of teaching tools and enhance, rather than detract, from learning.

Web-Based Mathematica Projects for Calculus

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Abstract: We incorporated web-based Mathematica projects into our Spring 1998 offering of a first-semester calculus course. This paper describes our projects that were based on famous battles from history. The projects are provided at http://www.usafa.af.mil/dfms/projects/math141/spring98. Suggestions for adapting our projects to other computer algebra systems and disciplines are included.

At the United States Air Force Academy, we used web-based Mathematica projects in our Calculus I course. These projects were intended to expose students to the use of technology as a problem solving tool and at the same time test their understanding of basic calculus concepts. Each project was based on a famous battle from history. This paper gives a description of the projects, which are located at the following web address: http://www.usafa.af.mil/dfms/projects/math141/spring98.

All three projects had the same basic structure. First, an overview page introduced the project to the students and described what they were expected to accomplish. Then, the students read a short summary of the battle and answered a few questions about the battle. After that, the students used Mathematica to answer some calculus questions; these mathematical questions were related to some aspect of the battle. Finally, there was a page containing links to other sites that had related information to the battle, so those who were interested could easily explore the topic further.

The historical portion of the project had nothing mathematical about it at all. Its purpose was to expose the students to a bit of military history (an important goal at a military academy) and also make the project a little more interesting. The three battles used as themes for these projects were Gettysburg, Agincourt, and Verdun. The students would read a summary of the battle (not too long -- about three or four screens of information) and then answer some questions about the battle. These questions ensured the students actually read the description of the battle, but they only accounted for about 20% of the project's total points. Because the Air Force Academy encourages character development in all its classes, these questions would sometimes be ethical in nature. For example, one question from the Battle of Agincourt asked whether or not it was appropriate for Henry V to give the order to kill the unarmed French prisoners of war.

The meat of each project was contained in the Mathematica portion. This is where the students' understanding of calculus concepts was tested, as well as their ability to use technology as a problem solving tool. The math questions were linked to the battle in some way. For example, a key weapon in the English defeat of the French at Agincourt was the long bow. So, the students were given a function (based on real data) that gave the height of an arrow shot from a long bow, and they were then asked to plot the function, interpret the plot of the height to give information about the velocity, calculate average and instantaneous velocities of the arrow, and determine how long the arrow was in the air. The students used Mathematica to answer the questions and turned in a printout of the Mathematica notebook to be graded.

These projects required the use of two technologies. The first was the use of the internet, which was nice but not essential for a math course. It made the project more

appealing through the use of pictures and multimedia (we used a video clip of actual footage from the trenches of Verdun), and the page of related web links made if very easy for those who wanted to explore further to do so. However, the historical content could also have been conveyed through the use of a handout. For those who can easily create and post web pages, though, it seems worth the effort to use the internet since today's students are great web surfers and love flashy pages.

The second use of technology was Mathematica. We wanted to show the students how computer algebra systems can make their lives easier by eliminating the tediousness of long calculations and by easily plotting functions to help visually understand a problem. Since the vast majority of our students are technical majors, we want them to use technology early and often throughout their academic career here.

The feedback from the students about these projects has been very positive. Though many complain about Mathematica being picky on syntax, they seem to realize they will be using technology throughout their careers and that they need to be comfortable with its use. They also seemed to enjoy learning about the battles while at the same time learning math concepts.

Development and Use of Multimedia Courseware using HTML

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Abstract: This paper focuses on the development and use of multimedia courseware using HTML and various audiovisual devices in developing materials that foster communicative and cooperative learning activities designed to encourage student creativity and enhance the learning experience. It demonstrates the advantages of instantaneous feedback through the use of computer programs, and offers examples of student-teacher collaboration in the development and use of these materials and activities. Specific demonstrations focus on content-based instruction in Japanese, though the basic principles may be applied to the study and teaching of all languages.

Introduction

Due to the continuous and rapid development of technology, our society is undergoing radical transformations in every conceivable field of human endeavor. In the field of instructional technology, the increasing use of media centers and computer assisted language laboratories has in many cases outpaced the integration of that technology with classroom instruction. Indeed, many language instructors find the prospects of using this novel technology to be both daunting and even alienating. This has been particularly so in the case of teachers of the less commonly taught languages who have tended to rely heavily on traditional means of instruction or allowed their colleagues in the more commonly taught languages to break new ground before timidly or reluctantly exploring the possibilities presented by the new forms of electronic media.

According to a recent study in Texas (Moore, Morales & Carel, 1998), most teachers will make considerable use of traditional video materials, but few instructors will venture into the realm of interactive media such as CD-ROMs, videodiscs, and the World Wide Web even in the teaching of the target language's culture. Teachers are aware that computer assisted language learning has definite advantages when it comes to combining text, graphics, sound, animation and video, yet teachers continue to rely heavily on textbooks. According to the Moore study, among the small percentage of teachers who actually did try to incorporate computer technology into their classroom instruction, more experienced teachers (with 6-10 years teaching experience) tended to use the new technology more than less experienced teachers (with less than 5 years experience). In other words, more experienced teachers, despite being somewhat wary of and intimidated by the new technology, made a conscious effort to learn and try to integrate computer technology into their classrooms, than did younger and less experienced instructors who often were more familiar with the new media.

It is clear then that a number of experienced educators are very much aware of the potential that the new technology holds in enhancing the learning process. It is also clear that enthusiasm for the new media is compromised by several factors, including (1) the inability of many schools to adequately equip themselves with the hardware and resources required by advanced technology; (2) the dearth of satisfactory software programs, CD-ROMS and videodiscs on the commercial market; (3) the cost of these programs, particularly when so few address the needs of the curriculum; and (4) the time constraints required to compile the scattered resources of the WWW in order to make them useful in day to day classroom instruction.

Koppany (1995) notes -- particularly in the less commonly taught languages -- that with few exceptions there is a shortage of usable foreign language software. Most of the available language learning software lacks relevance, currency, adaptability, authenticity and communicative interaction, all essentials in teaching for proficiency. Teachers are left to struggle with the issues involved in the proper integration of computer technology into the curriculum. As Koppany states, "software producers continue to churn out FL tutorials of dubious value, while teachers continue to shake their heads in disappointment."

Rationale of the Project

The recently published National Standards for Foreign Language Learning (1996) emphasizes the key "5C" concept in language teaching: Communication, Cultures, Connections, Comparisons & Communities. Specifically, the National Standards advocate a close coupling of the target language with its attendant culture, enabling the language learner to compare and contrast his/her own language and cultural background with that of the language and culture he/she is attempting to learn. The Standards also advocate an integration of language learning with information and knowledge from other academic and practical disciplines, requiring teachers to present geographical, historical, socioeconomic, and cultural materials along with materials used in day to day language instruction.

No single language textbook can address this rather holistic approach. Consequently, the Department of Foreign Languages here at the United States Air Force Academy has sought to create language teaching materials that incorporate a cultural context. We linked a wide range of sociocultural topics and information related to specific areas of our curriculum and made it readily available to students over the Internet. Currently, the Japanese Language Program has four categories of programs to supplement language instruction: (1) conventional language lessons, namely Listening Comprehension Exercises and Reading Comprehension Exercises; (2) Culture Learning Lessons, including geography, history, society & culture; (3) Literature; and (4) Government and Constitution of Japan, including the armed forces and diplomatic relations.

The production of this courseware is based on HTML, a very basic and simple programming language. While the program lacks sophisticated bells and whistles, i.e., animation and/or 3D images, it does contain photographs, drawings, sound, and scanned Japanese characters. The scanned images of the characters enables anyone to view them on the internet without recourse to Japanese software, overcoming obstacles caused by the variety of different approaches to represent non-alphabetic writing that appear on different computer platforms.

The Importance of Collaboration with Students

One reason why commercial software often fails to address the needs of teachers lies in the fact that, more often than not, it is produced by computer technology specialists who focus more on the medium than on the content of their products. Also, most software developers seek to gear their products to as wide an audience as possible. While understandable from a purely marketing perspective, all too often the generic product ignores the needs of specific communities of learners.

Good teachers know that effective transmission of subject material occurs when it is relevant to a student's background and interests. Presenting materials from the teacher's perspective (or that of a remote software engineer) and forcing students to passively receive

their knowledge is not likely to be as successful as getting the student to actively participate in the acquisition of knowledge. Supposedly, this is the whole point of the interactive media, but experience shows that even the best interactive programs will be conduits of passive learning unless the teacher provides the structure for interactive learning to take place. To do this effectively, teachers must interact with their students. They must delve into the backgrounds, interests, and aspirations of their particular students.

Quite often the computer skills of students are more advanced than those of their instructors, and it is here where students and teacher can cooperate and collaborate in the production of materials that are not only relevant to the particular needs and interests of the students but are also relevant to the course and an excellent means of exploring different aspects of the subject material. Naturally, cooperative and collaborative learning need not and should not be derived exclusively from computer generated materials, but collaborative exercises in this area may go a long way towards providing the material the instructor wishes to cover while also providing a pro-active means for the students to participate in their own acquisition of knowledge.

Granted, time and resource constraints may limit the effective participation of all students, particularly in large classrooms, in the production of software material, but even collaborative efforts with a select number of students will benefit the class as a whole as the selected students take on the role of peer instructors and demonstrate what they have learned through the medium of their simple products before the class. Or the teacher can assign cooperative mini-projects to groups of students and compile each of the smaller projects into a cumulative whole.

Such projects often take advantage of the wide variety of backgrounds that students can bring to the study of specific subject material. For instance, in the Japanese history class here at USAFA, students with strong backgrounds in western and world history, philosophy, or literature provided fresh perspectives and interpretations about the relevance of Japanese history for themselves and the class as a whole. While this sort of interaction can be achieved through simple class discussion, structuring ideas and facts into a coherent form through the electronic media lends itself to more articulate forms of expression and a heightened appreciation of the material. In addition, the concrete product which can be used as an example in subsequent classes, is far less transitory than the mere utterances that come and go in a mere discussion of the subject. Consequently, I have been encouraged to work with students whose majors are as diverse as Legal Studies, Philosophy, History, and other social sciences.

Conclusion

All of the courseware that I and my students have put together during the past two semesters can be viewed at USAFA's Department of Foreign Languages intranet website (http://intraweb.usafa.af.mil/dff/languages/Japanese/index.htm) as well as through the Colorado World Language Improvement Program's site which is linked to our departmental site on the internet (http://www.usafa.af.mil/dff/clip/japanese/index.htm).

These collaborative efforts with my students have provided them with a deeper understanding of the subject matter as well as providing me, as their instructor, with material and perspectives that will appeal to and inform students of subsequent classes. The use of the HTML programming language provides a simple means of creating student-generated webware that can be learned quickly and easily. It is a cost effective means for creating

relevant supplementary material that can be geared to the specifics of classroom instruction and is limited only by the amount of effort and imagination the instructor and students are willing to invest. Projects of this nature can go a long way towards addressing the specific needs and requirements of a particular subject matter, curriculum, or classroom.

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A Primer to Interactive WWW-Based Tutorials

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Abstract: One of the best features of the WWW is the ability to construct interactive text and graphic-based pages. There are many approaches to obtain different levels of interactivity within a web-based document. Some approaches, such as JAVA or cgi-scripts written in PERL, require sophisticated programming abilities. Other approaches use simpler HTML codes, which can be modified with JavaScript for greater flexibility. The purpose of this paper is to provide some examples of different programming tools that can be used to incorporate interactivity into web page design.

One of the best features of the WWW is the ability to construct interactive text and graphic-based pages. These interactive pages give students the chance to input quiz answers, alter the parameters of a computer simulation or model, and receive immediate feedback on their work. Although some of these designs require sophisticated programming ability and/or web development software, other interactive web pages can be created by incorporating short segments of programming code or "scripts" into the HTML document by someone with little or no programming experience. The purpose of this paper is to give a brief overview of interactive web page programming from the simple to the complex, citing examples from both the sciences and the humanities.

One method of developing interactive web pages is to use PERL, a standard CGI (common gateway interface) programming language, which is stored and executed by the web server. Quiz programs written in PERL can give immediate feedback to the student on practice or graded exams. After the student selects their choices, the PERL script grades the quiz, sends the students responses to a file and gives the student feedback as to which questions they missed. Multiple choice quizzes, such as the General Biology test bank at the University of Colorado (http://www.colorado.edu/itrc/quiz/halloran/EPOB1210777.1.html) can be modified to include a variety of options including correct answers to missed questions and supplemental material for further study. This program can also be used for true-false type questions.

Programs written in PERL are not limited to multiple choice and true-false types of exam questions. Students can also get feedback on short answer questions and questions based on diagrams and illustrations. In the online tutorial to accompany the Power of Logic philosophy textbook, students get the opportunity to practice complex mathematical probability problems (http://www.poweroflogic.com/cgi-pol/Arith/arithmetic.cgi?exercise=11.1A) and are asked to solve logic puzzles using Venn diagrams (http://www.poweroflogic.com/cgi-pol/Venn/venn.cgi?exercise=5.2). For these tutorials, students are only told that their answers are right or wrong, providing them with unlimited tries to solve the problems.

One advantage to using a server-side language such as PERL, is that it is easy to track an individual or group of students' performance by having output from the program generated to a file. Instructors can access these files and assess how many students are answering the questions correctly. Depending on the formatting of the output files, quizzes can be set up to record answers for a whole class anonymously, or an individual student's responses to each of the questions can be tracked. This output can also be made available to the students and

incorporated into an online grade book with other course scores (http://snaefell.tamu.edu/~colin/Logic/lookmeup.html).

JAVA is another language with a lot of versatility and is useful for programming complex interactive simulations and models. JAVA programs or "Applets" are downloaded from the server onto the client's browser. A good example of a JAVA Applet is the Evolve-IT simulation (http://www.cdl.edu/EvolveIT/Simulation/SimApplet.html). In this simulation, students manipulate the parameters of two groups of birds living on isolated islands and submit these parameters to the server, which subsequently generates population survival curves. There are no right or wrong answers to be graded, but rather side by side comparisons of the two models generated from students' inputs are displayed.

Constructing PERL and JAVA scripts to develop sophisticated interactive tutorials both require a considerable amount of programming knowledge. However, some simple tasks such as interactive image maps can be created using basic HTML. For example, when a person mouse clicks on a state on the United States Squirrel Finder map (http://spot.colorado.edu/~halloran/sqfinder.html), a listing of the squirrel species found within that state are displayed.

Image maps can also be enhanced using JavaScript, which is another programming language that is run on the client side or browser. JavaScript enabled maps are slightly more complicated to compose than maps done in HTML, yet allow for a greater amount of interactivity. For example in a microscope tutorial image map (http://spot.colorado.edu/~halloran/scope.html), placing the mouse over part of the microscope will have a different effect than clicking on that same part. JavaScript is not as powerful as server side scripting, but can be useful for simple routines. In addition, unlike PERL or JAVA Applets, the source code can be easily viewed. Therefore if you see something on the web that you like, you can easily incorporate it into a new page.

There is a lot of overlap among languages in their usefulness for designing interactive web pages. For example, multiple choice quizzes can be written in both PERL and JavaScript, with slightly different features. Also, it is often possible to combine scripts from different languages to achieve the desired effect. When selecting a language, you must take into account the types of interactivity on the page, your programming skills, and whether the outputs need to be written to a file. The rest of the interactive page design is dependent upon your imagination.

Implementation and Assessment of Flexible Learning in Geography 210

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Abstract: One of the major experiments of the Geography 210 revision program is the design, implementation, and assessment of flexible learning lessons. Of the 17 sections of Geography 210 for the Spring 1999 semester, two were designed as experimental or "Z" sections. The two instructors design, produce, and implement one or more lessons using a course development tool designed to assist busy faculty with multimedia development. The instructors use the Course Materials Toolkit as lesson templates for instructional development. Once complete, students work on the lessons either independently or in the usual classroom setting where the instructor serves as a mentor. Following implementation, an assessment team measures the effectiveness and efficiency of these lessons.

[Manuscript unavailable]

Personal Computer Web Site Support for Instruction

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Abstract: Descriptive data are reported about the use of a web site on an instructor's personal computer for information dissemination to students. Simple descriptive data were collected concerning web site hit rates as functions of sequential lessons and days. In addition, subjective ratings of site usefulness and quality were acquired approximately halfway through the semester and near the end of the semester, four days before the final exam. The project produced mixed reviews of the web site from the users, an easily interpretable hit rate pattern and one practical lesson about file names and formats. For an instructor versed in HTML or the Netscape Composer® or Microsoft FrontPage® editing environments, the personal web server concept will prove to be a useful tool for the dissemination of information to cadets and other students. This conclusion must be caveated as follows: The users must all have access to the site and be able to use web browser software, and the network must function reliably.

New technologies provide added approaches, beyond traditional approaches, for making instructional information available to students. Descriptive data are reported here about one approach: the use of a web site on an instructor's personal computer for information dissemination to students. The rationale for the study included several considerations. First, our instructors and students were linked by a local area network (LAN), to which all were connected directly. The direct connections provided high speed transmission of data. Second, there was already a large amount of communication between instructors and students by electronic mail (e-mail) on this network, and students reportedly used the LAN extensively to "surf" the World Wide Web. Thus, there was an assumption that the students had at least basic computer skills relevant to this approach. Finally, there was an assumption that the idea of accessing instructional data by web "browsing" would be attractive to many students.

Methods

Experimental Design. No experimental manipulations were used. Simple descriptive data were collected concerning web site hit rates as functions of sequential lessons and days. In addition, subjective ratings of site usefulness and quality were acquired approximately halfway through the semester (25^{th} lesson out of 42 lessons) and near the end of the semester (lesson 42), four days before the final exam. The two sets of ratings were subjected to simple, non-parametric analyses structured to detect differences that might have occurred as a function of elapsed time.

Technology. The site was placed on an Intel Pentium®-based, 133-mhz computer with 32 MB RAM and its own Internet protocol (IP) numeric address. The web site capability was supported by Microsoft Personal Web Server® software, supporting the hypertext transport protocol (HTTP). The site's one "web" page was prepared initially using Netscape Composer® software, and edited later in its raw hypertext markup language (HTML) using the word processing application program, Microsoft Word 97®. The site was available only on the LAN, and not from the World Wide Web.

The contents of the site were as follows. A single HTML page, the home page, included a welcoming statement that identified it as the home page for the applicable class.

This confirmed for the student his or her web location. The page also included an attractive image relevant to the course and a series of hypertext links. Most of the links were to word processor documents at the site. These documents were (1) lists of course objectives for each of the several blocks of the course and (2) the instructor's extensive lesson plan notes, organized by lesson objective. These notes included information from the course texts and additional information provided by the instructor. Because the course was a "new preparation," using a new textbook, the lesson notes only became available on the site shortly before the day of the given lesson.

There was also a question and answer page at the site. This page was used primarily to display instructor discussions about questions that had posed difficulties on mid-term exams during the course. The home page also contained and displayed a "hits" counter, based upon public domain common gateway interface (CGI) software. The counter did not record the use of the word processor to edit and inspect the home page. This reduced sharply the number of non-data webmaster hits counted at the site. The other home-page contents included hypertext links for e-mail to each of the two instructors in the course and information about the instructors' office and telephone numbers. There was also a hypertext link to a relevant, interesting external site.

Subjects. The subjects were 63 cadets at the Air Force Academy. Primarily, they were in their third year at the Academy and taking their first or second majors class as Human Factors Engineering majors in the Department of Behavioral Sciences and Leadership during the fall semester of 1998. The class, itself, was named *Introduction to Human Factors* (BS 373). The cadets were grouped into four sections. The instructor who was the investigator and web site developer taught one of these sections, and the instructor who was the course director taught the other three sections.

Procedures. The site was introduced to the cadets during lesson 4. They were given its IP address and told of its contents. This information was repeated in response to cadet questions throughout the remainder of the course. Web site hits were recorded anonymously and automatically, then reviewed and entered manually day by day into a spreadsheet by the investigator. Webmaster hits were subtracted from the total number of hits prior to data reduction and analysis. The simple questionnaire (attached) was administered twice, anonymously, during class time. The questionnaire asked for the cadet's estimated number of hits and three ratings: the usefulness of the site, the quality of the information on the site and the usefulness of the Intranet web server concept. Ratings were on a 9-point scale anchored with the following terms/phrases: Excellent (9), Good (7), Borderline (5), Not very good (3), and Extremely poor (1) (Babbitt & Nystrom, 1989).

Due to an inherent unreliability of the LAN that was peculiar to this semester, there were many anecdotal reports by cadets of an inability to access the web site. Thus, after the first graded review (GR; midterm exam), the lesson plan notes present on the web site were made available to the cadets using hard copies, an intranet hard drive and e-mail in addition to the web site.

Results

The project produced mixed reviews of the web site from the users, an easily interpretable hit rate pattern and one practical lesson about file names and formats,.

The first use of the questionnaire generated 54 responses. The cadets' estimated number of hits overestimated by 11.8% the actual number of hits recorded at the site. The

mode of the distribution of ratings for the usefulness of the site was 7 ("Good"), ranging from 9 ("Excellent") to 3 ("Not very good"). The mode of the distribution of ratings for site information quality was 7 ("Good"), ranging from 9 to 6 (between "Good" and "Borderline"). The mode of the distribution of ratings for the Intranet server concept was 7, ranging from 9 to 1 ("Extremely poor").

The second use of the questionnaire generated 56 responses. The cadets' estimated number of hits overestimated by only 5.0% the actual number of hits recorded at the site. The mode of the distribution of ratings for the usefulness of the site was, again, 7 with a secondary mode appearing at 9 and a range from 9 to 1. The mode of the distribution of ratings for site information quality was 7, ranging from 9 to 5 ("Borderline"). The mode and range of the distribution of ratings for the Intranet server concept were the same as recorded at Lesson 25.

A nonparametric test was used, *post hoc*, to compare ratings from lesson 25 to ratings from lesson 42. The X^2 test for k independent samples (Siegel, 1956) was adapted for use. It was applied only to ratings of 6 and greater so that expected frequencies would be adequately large. The number of degrees of freedom for the test (df = 3) were halved (df = 1) to account for the lack of independent samples. (Note that, since the questionnaire was anonymous, there was no record of the repeated measures across lessons 25 and 42.) The results of the tests indicated no reliable change for perceptions of site usefulness ($X^2 = 1.526$, $p < 0.30$) or quality ($X^2 = 2.414$, $p < 0.20$) across lessons, but a significant change for the rating of the server concept ($X^2 = 4.260$, $p < 0.05$). The rating of the server concept declined reliably from lesson 25 to lesson 42.

Figure 5 shows the site hit rate as a function of lesson number (lessons 1 through 42 and the final exam). Figure 6 shows the site hit rate as a function of calendar date. Modes in the distribution of hits per lesson are evident leading up to the first (about 45 hits per lesson) and second GRs (about 28 hits per lesson) and the final (55 hits in the four days before the final) (Figure 5). The period leading up to the first student-led review (SLR) and GR, and to the final, were characterized by approximately logarithmic increases in hits as a function of elapsed time, while the increase during the period leading up to the second SLR and GR was less steep (Figure 6).

Table 1. Intercorrelation data.

	Lesson 25			**Lesson 42**		
	Usefulness	Quality	Concept	Usefulness	Quality	Concept
Hits	0.150	0.152	0.075	0.135	*0.385	0.065
Usefulness		**0.535	**0.415		0.211	**0.591
Quality			**0.425			*0.340

(*p < 0.05; **p < 0.01)

The relationships (Spearman r) among the various ratings and frequency of access were as shown in Table 1. All of the relationships were positive. Several relationships were statistically significant, as indicated. Perceptions of site usefulness and quality and the web server concept rating were positively intercorrelated at statistically significant levels at lesson 25 but less strongly intercorrelated at lesson 42. In particular, the positive relationship between perceived quality and perceived usefulness appeared to decline from lesson 25 to lesson 42. The distribution of the reported number of hits, which was cumulative across the course, shifted from lesser to greater right skew as more users accrued more hits, even though

the mode remained at 1 to 5 hits. The positive relationship between the reported number of hits and the perception of site quality appeared to increase from lesson 25 to lesson 42.

The practical lesson was related to the problem of dealing with different file naming and file formatting conventions. The web server was fully Windows 95® compliant. Thus, it dealt adequately with file names longer than 8 characters. The users' reported that their computers still had remnants of earlier operating systems that would not accept file names longer than 8 characters. Some users used Word 6.0® while others used Word 97®. The word processing documents on the web site were prepared using the latter, which produced file formats that were essentially unreadable by the former. The solution was to post these documents on the web site using file names of 8 or fewer characters and to export them from Word 97® in rich text format (RTF), which was readable by Word 6.0®. Of course, the export function produced file name extensions of "RTF" by default. Many users did not have an association in their Windows system between the RTF file name extension and their word processing program. Thus, they perceived an inability to open the files. To offset this problem, the files on the web site were renamed so that they all had DOC file name extensions, an extension recognized by default by Word 6.0® and Word 97®. The free Microsoft translation that would have allowed these Word 6 users to read Word 97 files was not widely disseminated among the users in this study.

Discussion

The server concept and specific site received reasonably good reviews. The modes of the distributions of ratings for the usefulness of the site, site information quality and the intranet serve concept through the first GR were all "Good" (a rating of 7) on a scale ranging from "Extremely poor" (1) to "Excellent" (9). All of the distributions were somewhat right-skewed, with just a few individuals providing low ratings. These results are supportive of continued efforts to provide information to cadets in this manner.

The patterns of site hits as functions of lesson occurrence and of calendar days were predictable. Not much activity early on, with a sharp increase as the first SLR and GR approached. This was followed by decreased activity, a secondary increase as the second SLR and GR approached, decreased activity again, and a sharp increase just before the final. The decision to provide hard copies of the lesson plan notes, present on the web site, to the cadets probably contributed to the reduction in hit rate observed after the first GR. The curve provided a useful quantification of the pattern of studying for the first GR, with a time constant (63.2% of the cadets active) of about 12 lessons for an exam at lesson 18.

The decline of the positive relationship between perceived quality and perceived usefulness from lesson 25 to lesson 42 probably reflected users' frustrations in gaining access to the site. The site's quality did not change from lesson 25 to lesson 42 and the distributions of the users' perceptions of site quality were similar at lessons 25 and 42. However, the distribution of ratings of perceived usefulness was much more varied at lesson 42 than the distribution at lesson 25. Apparently, many users indicated by their usefulness ratings at lesson 42 that the quality of the material at the site was only potentially useful because access was unreliable.

There was a moderate positive relationship between perceived usefulness of this site and the more general rating of the server concept, at both lesson 25 and lesson 42. This pattern suggested that, for students with limited exposure to web site class management

techniques, the two questions did not produce very independent responses. The more general question need not be used for relatively naïve users.

The apparent increase in the positive relationship between the reported number of hits and the perception of site quality from lesson 25 to lesson 42 was probably caused by the naturally occurring increase in the variance in the number of hits accrued by users. This effect should be viewed simply as a statistical artifact of increased homoscedasticity. However, the positive relationship, itself, may have reflected higher numbers of hits by those users who perceived higher quality in the site's materials, and vice versa.

The unreliability of the LAN produced a tendency toward a misplaced trust in the network as a communication tool, leading to user frustration and unsolicited comments on the questionnaires. Three of the five unsolicited comments provided by users at lesson 25 revealed this frustration:

- "Not able to get on for some time."
- "I do not like the web; it is difficult and it never seems to work."
- "I wish I had hard copies because the Internet (sic) is <u>EXTREMELY</u> unreliable; it is very intermittent and you cannot depend on it as a study source."

Six of the ten unsolicited comments provided by users at lesson 42 revealed also the frustration:

- "The net being down kept me from accessing the site."
- "Sometimes it [the net] works, sometimes it doesn't (60/40 maybe) and that's too unreliable when my grade depends on it."
- "I have trouble getting on the intraweb often. Not as unreliable as the web though. The Internet is useful, but I would rather have hard copies because our net is <u>extremely</u> unreliable. In fact, when I try to use it, it is down more than up."
- "The server is down too often."
- "[Usefulness is excellent] when it works!!!"
- "The website was OK, but the lack of Intranet makes the website hit or miss. It seems like many cadets after experiencing 2 or 3 failures don't even try anymore."

These anecdotal representations of frustration were underscored by the quantitative finding that the rating of the server concept declined reliably from lesson 25 to lesson 42.

Conclusions

For an instructor versed in HTML or the Netscape Composer® or Microsoft FrontPage® editing environments, the personal web server concept will prove to be a useful tool for the dissemination of information to cadets and other students. This conclusion must be caveated as follows: The users must all have access to the site and be able to use web browser software, and the network must function reliably.

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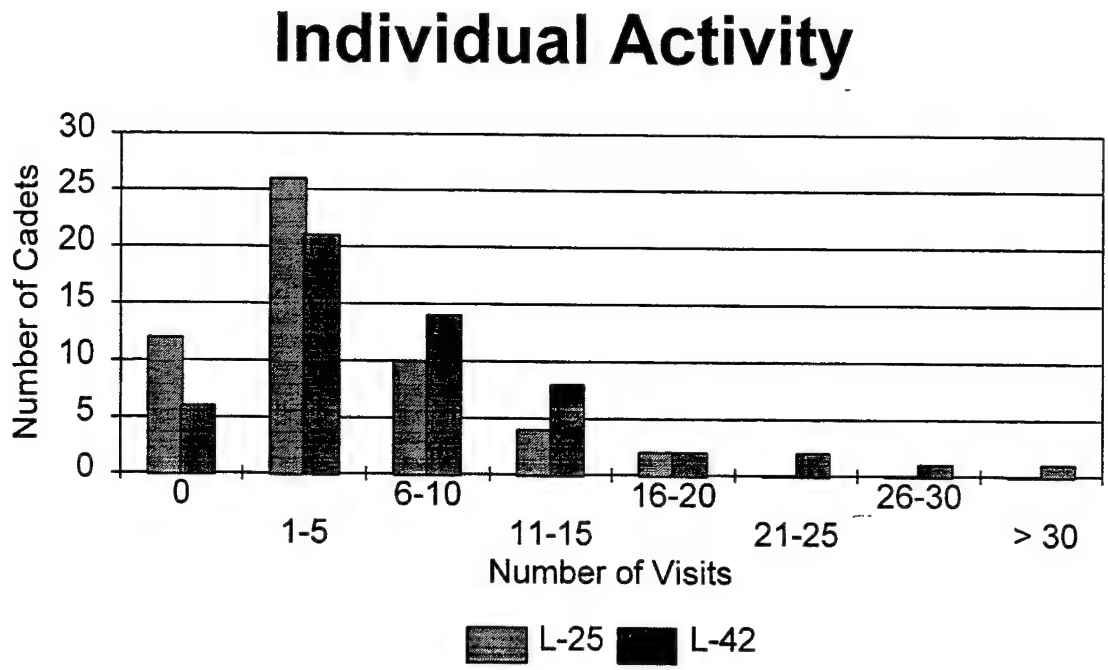

Figure 1. Reported numbers of site visits.

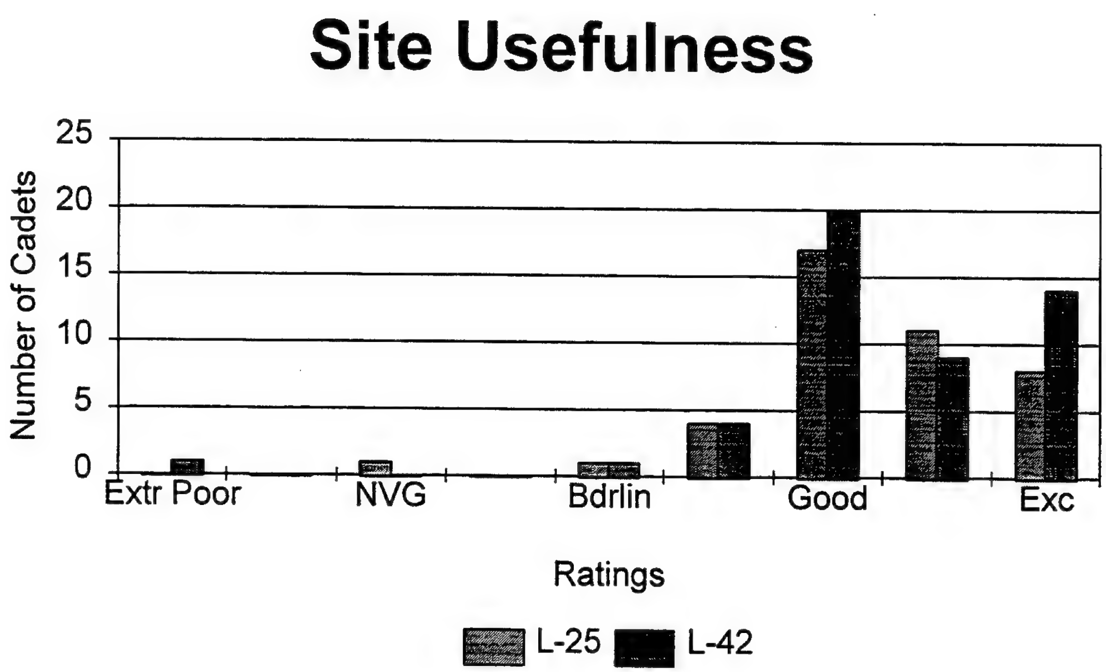

Figure 2. Ratings of site usefulness.

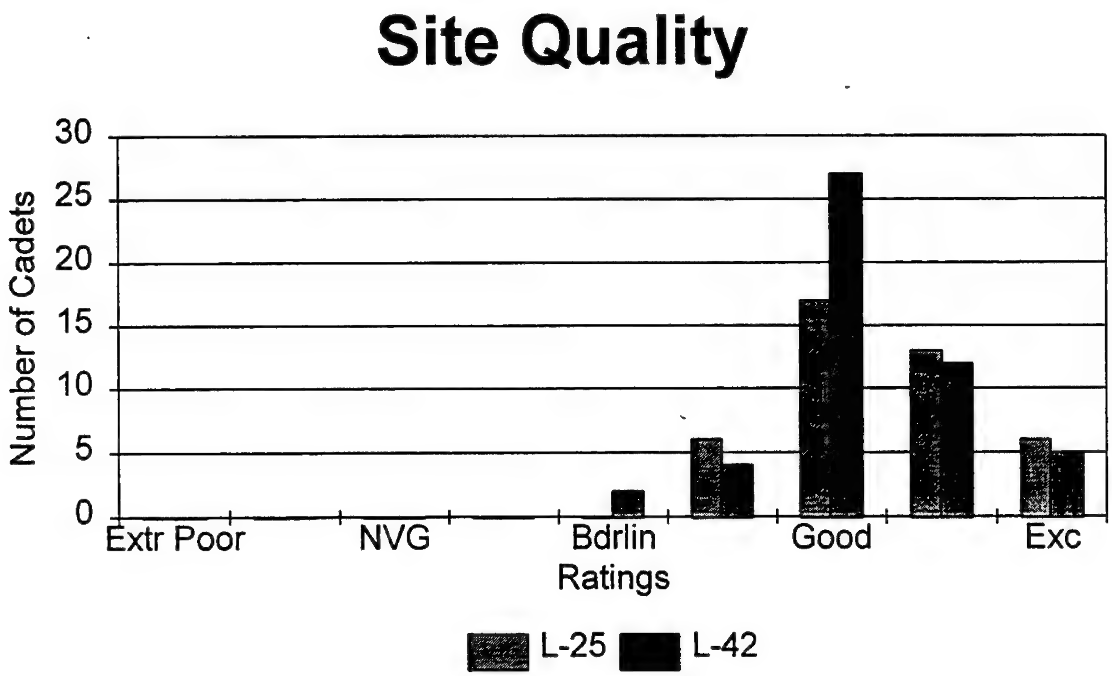

Figure 3. Ratings of site quality.

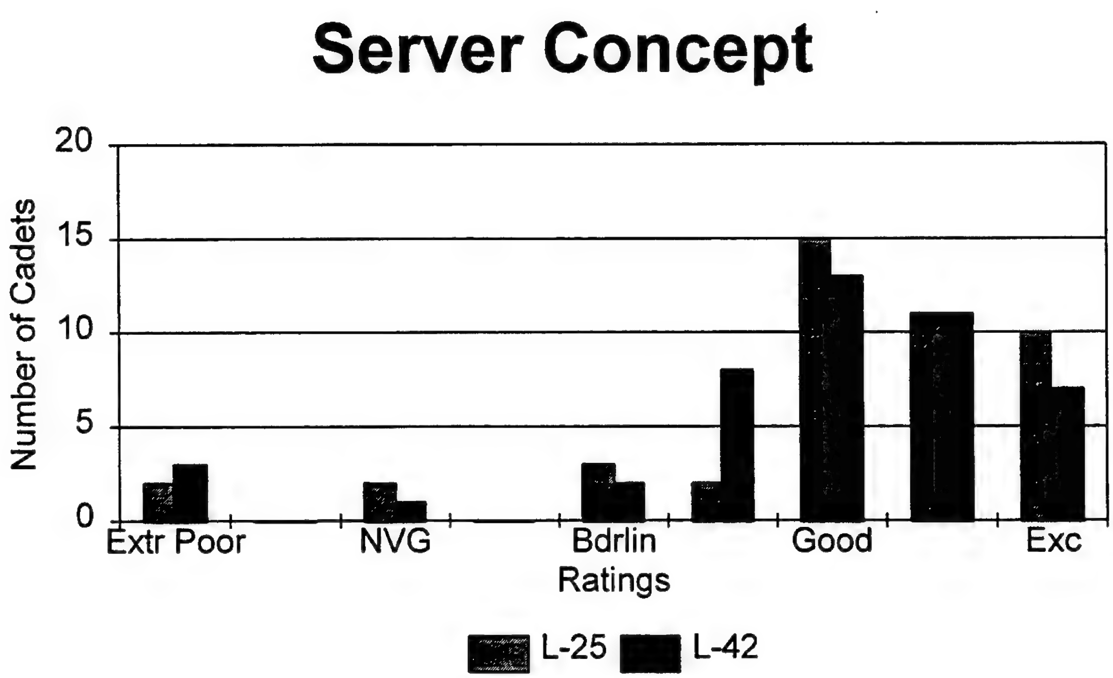

Figure 4. Ratings of the Intranet web server concept.

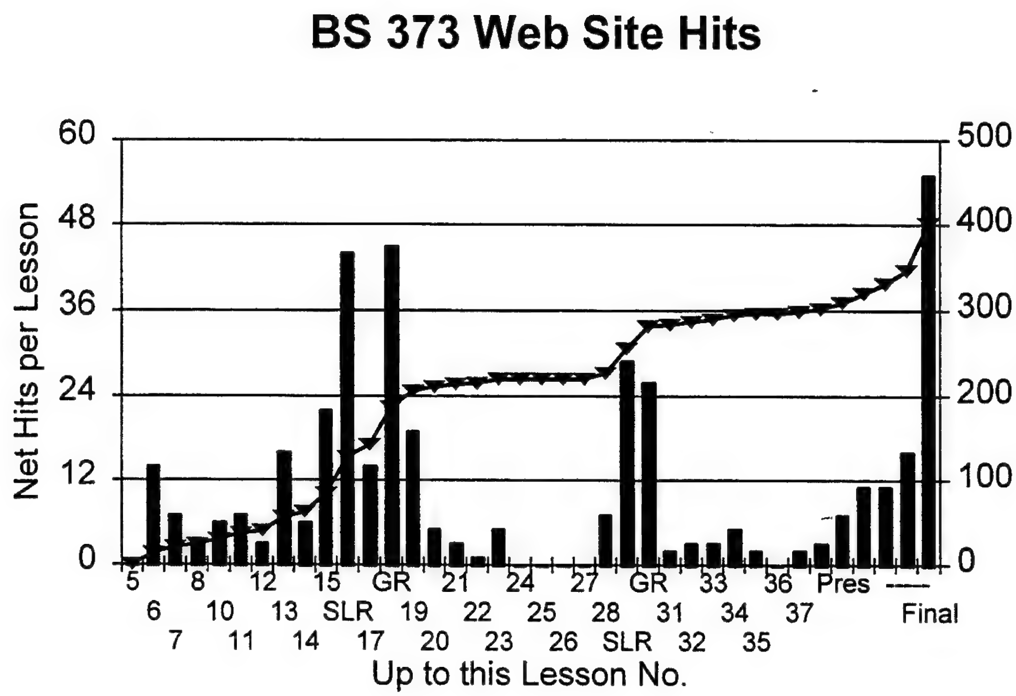

Figure 5. Site hit rate as a function of lesson number.

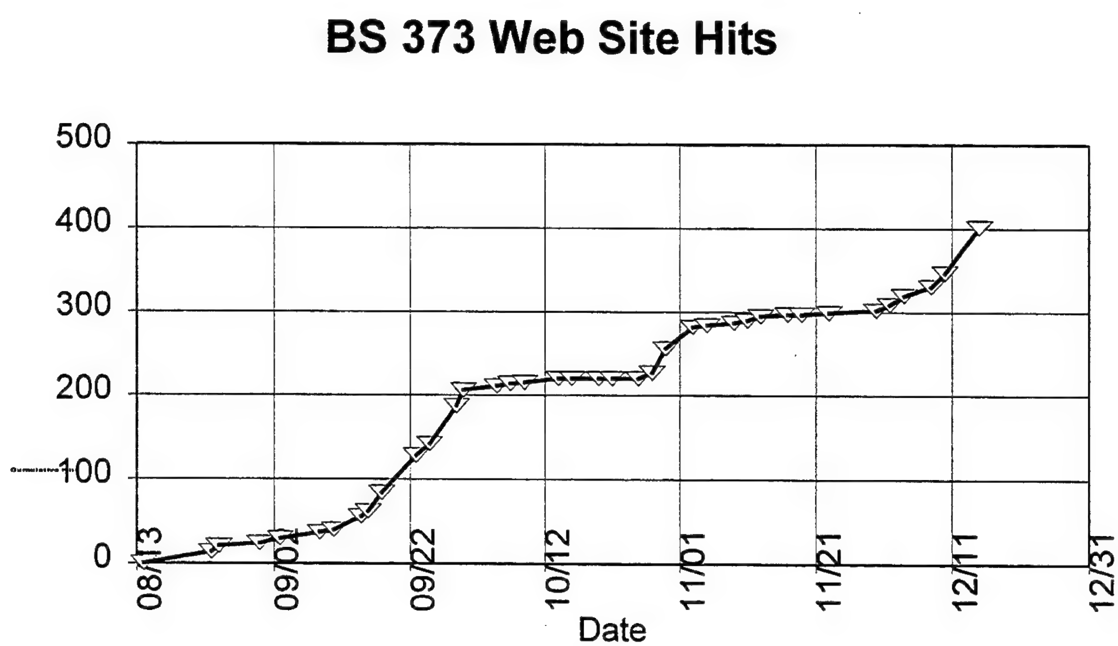

Figure 6. Site hit rate as a function of calendar date.

Appendix A: Anonymous BS 373 Web Site Questionnaire

1. How many times have you accessed the BS 373 site this semester (mark one)?

___ Unwilling or unable to access the site (go to question 5)
___ 1 to 5 times ___ 6 to 10 times
___ 11 to 15 times ___ 16 to 20 times
___ 21 to 25 times ___ 26 to 30 times
___ more than 30 times

2. Please rate the **usefulness** of the **BS 373 site** for acquiring lecture information.

___ Excellent
___ Good
___ Borderline
___ Not very good
___ Extremely poor

3. Please rate the **quality** of the lecture information on the **BS 373 site**.

___ Excellent
___ Good
___ Borderline
___ Not very good
___ Extremely poor

4. Please rate the **usefulness** of the **Intranet web server concept** for acquiring class information.

___ Excellent
___ Good
___ Borderline
___ Not very good
___ Extremely poor

5. If you are having **problems** on your computer with e-mail, access to the intranet, access to the web, or other operability problems, **and** wish to have help from DF computing, please sign up on the **other** sheet that will be handed around.

The 1999 Faculty Notebook Computer Study

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Abstract: This investigation, the first in a series of multi-disciplinary studies, will assess the effect of portable computers on the faculty's ability to contribute to teaching, research, and service. The investigation employs a mixed design. The experimental group consists of faculty members who volunteered to turn in their desktop computers for notebook computers. The control group consists of faculty members who requested and received new, replacement desktop computers with a different operating system than they had been using. A series of six surveys were scheduled for administration on-line throughout one calendar year to collect longitudinal data on hardware and software use, ease of use, and frequency of use within the experimental and control groups. We hypothesized here that the two groups would not differ with respect to age, military-civilian mix, gender, academic rank, military rank, computer experience, teaching experience, and length of time at USAFA. Most hypotheses were supported. However

The US Air Force Academy had considered the option of issuing portable notebook computers to cadets in place of desktop computers for several years. The US Military Academy, West Point NY, had conducted a small pilot study of notebook computers in 1994. Eighteen cadets (one classroom group) were given notebook computers for the entire spring semester. The notebook computer was chosen to match the capabilities of the cadet desktop model. Due to the high failure rate and high cost of the notebook computers (when compared to desktops), the researchers concluded that notebook computers were not yet acceptable replacements for desktops.

Mayville State University (MSU) and Valley City State University (VCSU) in North Dakota had adopted notebook computers for all students and faculty in 1996. They reported overwhelmingly favorable results including increased level of communication on campus, improved student retention rates, increased instructor use of technology, improved research abilities, and improved ability for students to work in groups. When considering these results, please we noted that the MSC/VCSU study confounded the effects of issuing computers to all students with the effects of notebook computers, themselves.

Most researchers had agreed on the advantages of notebook computers, citing the opportunity to bring computers to class, the ability to bring computers on athletic and other trips, ease of storing computers, ease of transporting a failed computer for repair, equal access to computers across disciplines, increased number of content delivery options, and the ability to create a lab environment in any classroom.

Researchers had also tended to agree on the disadvantages of notebook computers. The West Point researchers were disturbed by the failure rate among notebook computers (31% of the computers failed during the study). Other disadvantages included the 12 to 18

month "technology gap" for notebooks, lack of upgrade capability, short battery life, increased repair costs, and ergonomics problems associated with the small screen and small keyboard.

Since the West Point study, notebook computers had become less expensive, more powerful and more durable. A listing of "Notebook Colleges and Universities" included over 50 institutions[9]. The time was ripe for USAFA to conduct its own investigations to assess the feasibility of notebook computers as replacements for cadet desktop computers. Fiscal Year 98 fallout money provided funding for 100 Pentium II notebook computers for faculty.

This investigation was planned as the first in a series of multi-disciplinary studies designed to assess alternatives to traditional desktop computers. Specifically, the plan was to assess the effect of portable computers on the faculty's ability to contribute to teaching, research, and service. The objectives were to determine:

- The criteria under which notebook computers were feasible alternatives to desktop computers.
- How notebook computers affected the faculty's teaching, research, and service.
- Which features of notebook and desktop computers faculty used.
- Which software products faculty used on notebook and desktop computers.
- The criteria under which a similar investigation should be conducted with cadets.
- A statistical basis to facilitate the identification of potential applications of notebook computers for the Air Force and Department of Defense.

This paper reports the results of a descriptive and comparative analysis of entry survey data, collected at the beginning of the faculty project, including user demographics and prior experience with computer use.

Methods

Experimental Design. The investigation used a mixed design. The experimental group consisted of faculty members who volunteered to turn in their desktop computers for notebook computers. Both the older desktop and newer notebook computers used the Windows98 operating system. The control group consisted of faculty members who requested and received new, replacement Pentium II desktop computers with a different operating system than they had been using (Windows NT replaced Windows 95/98). A series of six surveys were scheduled for administration on-line throughout one calendar year (November 1998 – December 1999) to collect longitudinal data on hardware and software use, ease of use, and frequency of use within the experimental and control groups. Other sources of data, not reported here, included maintenance logs, technology training rosters, network logs, and anecdotal reports. Descriptive statistics were used to summarize the group data and parametric and non-parametric methods were used to compare the two groups. We hypothesized that the two groups would not differ with respect to age, military-civilian mix, gender, academic rank, military rank, and computer experience.

Subjects. Members of the experimental group were a subset of over 100 volunteers who gave up their desktop computers in exchange for notebook computers. Since there were more volunteers than computers, the investigators selected those who were teaching and who

[9] http://www.vcsu.nodak.edu/offices/itc/notebooks/other.htm

had more than one year left at USAFA. The control group was a subset of 150 faculty members who received new desktop computers.[10]

Instruments. The survey package contained three surveys: Entry, Periodic and Exit. The subjective rating scales in the surveys were constructed with reference to Babbitt and Nystrom (1989) to help assure that respondents would differentiate among scale anchors. Only data from the Entry Survey are reported here.

Procedures. The Entry Survey was taken by experimental group participants shortly before their notebook computers were issued, and by control group participants shortly after their new desktop computers were issued. The Periodic Survey was to be given six times, with a specification each time about the computer and the period that was to be rated:

1. In conjunction with the Entry Survey. The survey applied to the participant's experience with his or her older USAFA desktop computer during the preceding three months
2. Mid-spring semester 1999. The survey was to apply to the participant's experience with his or her new USAFA computer during the first half of the spring semester.
3. End of the spring semester 1999. The survey was to apply to the participant's experience with his or her new USAFA computer during the second half of the spring semester.
4. End of the summer 1999. The survey was to apply to the participant's experience with his or her new USAFA computer during the summer.
5. Mid-fall semester 1999. The survey was to apply to the participant's experience with his or her new USAFA computer during the first half of the fall semester.
6. End of the fall semester 1999. The survey was to apply to the participant's experience with his or her new USAFA computer during the second half of the fall semester.

The Exit Survey was to be given in conjunction with the 6th Periodic Survey. The Entry Survey, from which the data reported here were extracted, is shown as an attachment. The surveys were implemented in hypertext markup language (HTML) and common gateway interface (CGI) on a personal web server connected to the USAFA Intranet. The data were stored automatically in comma-delimited ASCII text files and imported into spreadsheet software for data reduction.

Group differences in demographics were assessed, for parametric data, by T test, with homogeneity of variance assessed by Levene F, and differences were assessed by X^2 for raw (not proportional), non-parametric, demographic data. The users also provided six subjective ratings on a scale of 1 (very unsatisfactory) to 6 (very satisfactory), with only those two anchor phrases on the scale. The six dimensions rated were labeled "personal computers," "laptop/notebook computers," "Internet e-mail," "USAFA Intranet," "web browsing" and "the USAFA dial-in service." Evidence of differences between groups was sought using the Kolmogorov-Smirnov 2-sample test (Siegel, 1956).

Results

As of 8 January 1999, 86 Notebook users and 48 Desktop users had responded to the Entry Survey. The age distributions of the two groups were not significantly different. The notebook user mean age was 36.4 ± 7.0 yr and the desktop mean was 37.5 ± 8.6 yr.

The military-civilian mix and the distributions of military ranks were nearly identical across groups, as shown in Figure 1. The mode of this distribution was O3 (Captain), with a

[10] The project was submitted for review by the USAFA Institutional Review Board, but was judged by the IRB to be a "normal educational practice" and thus was not reviewed by the IRB.

secondary mode for civilians. Proportions of male and female users were similar across groups: 19.8% of Notebook users and 18.8% of Desktop users were female. The distributions of academic ranks were nearly identical across groups as shown in Figure 2, with the mode falling at Assistant Professor. The histogram of the distribution of the two kinds of computers across academic divisions (Figure 3) revealed an apparent tendency for Engineering faculty to select the desktop configuration over the notebook configuration (X^2 = 5.16, df = 3, $p < 0.20$). The distributions of academic degrees were nearly identical across groups as shown in Figure 4, with the mode falling, interestingly, at the doctoral level.

The total amount of computer experience did not differ significantly between the two groups. The Notebook group reported 15.5 ± 5.7 yr and the Desktop group reported 16.6 ± 4.8 yr. Similarly, the total amount of *personal* computer experience did not differ significantly between the two groups. The Notebook group reported 12.6 ± 3.7 yr and the Desktop group reported 13.4 ± 4.8 yr. The two groups also did not appear to differ significantly with respect to previous notebook computer experience, though the distributions were significantly right-skewed. Both groups reported an average of about 2 to 3 yr of previous notebook computer experience.

Experience using e-mail did not differ significantly between groups. The Notebook group reported 5.8 ± 3.2 yr and the Desktop group reported 6.3 ± 2.2 yr of e-mail use. Similarly, experience with the USAFA Intranet did not differ significantly between groups. The Notebook group reported 2.4 ± 2.4 yr and the Desktop group reported 2.6 ± 2.6 yr of Intranet experience. Experience using the World Wide Web (WWW) did not differ significantly between groups. The Notebook group reported 3.6 ± 1.7 yr and the Desktop group reported 3.8 ± 1.5 yr of WWW use.

The two groups also did not appear to differ significantly with respect to experience with the USAFA dial-in service, though the distributions were significantly right-skewed. Both groups reported an average of about 0.5 yr of previous notebook computer experience. Experience with other providers' dial-in services did not differ significantly between groups. The Notebook group reported 2.9 ± 3.1 yr and the Desktop group reported 2.1 ± 2.1 yr of other dial-in use.

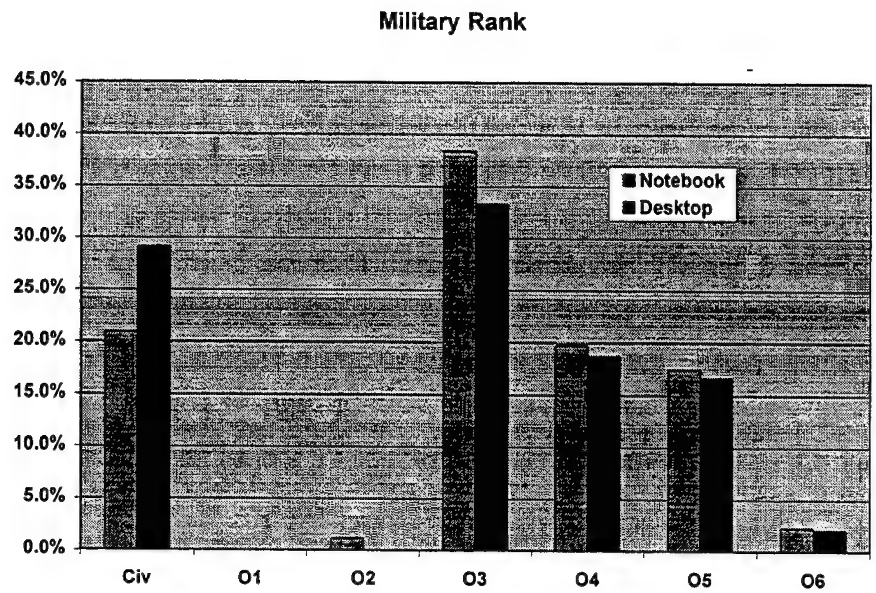

Figure 1. Military-civilian mix for the Notebook and Desktop groups.

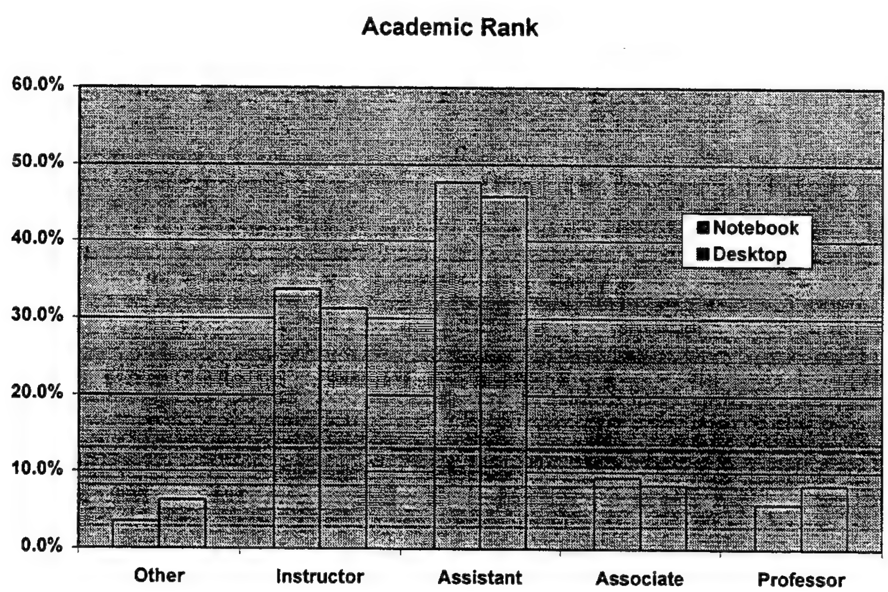

Figure 2. Academic rank for the Notebook and Desktop groups.

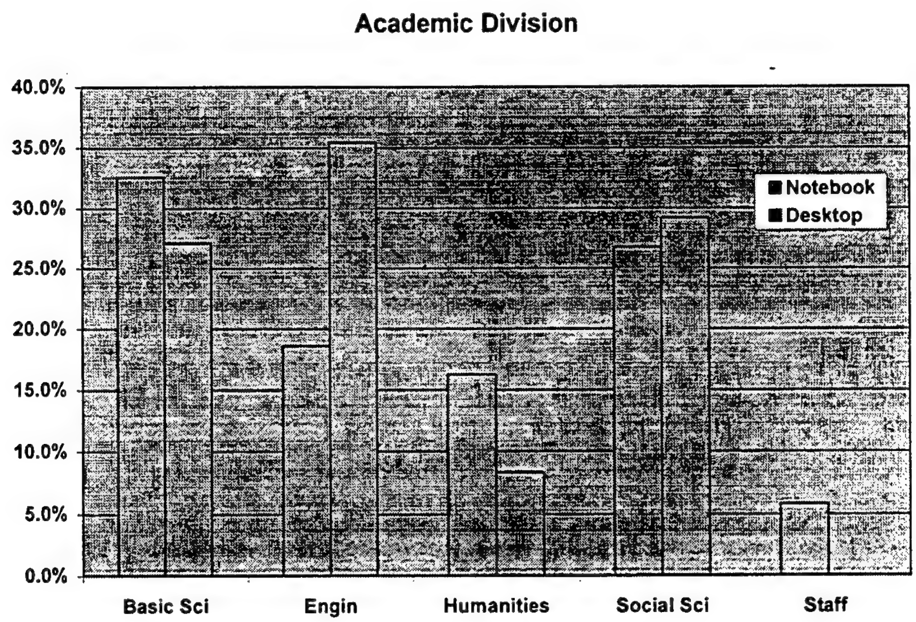

Figure 3. Distributions of computers across academic divisions.

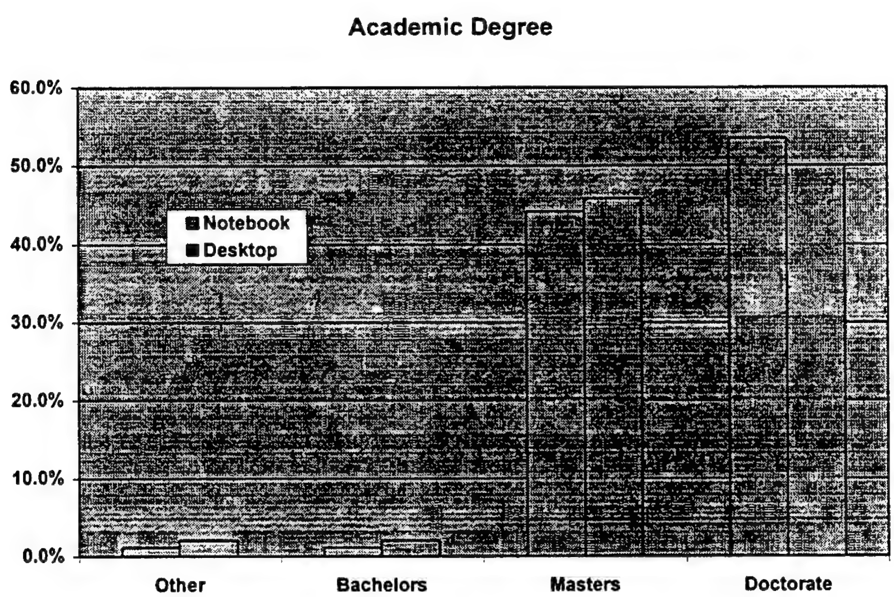

Figure 4. Academic degrees for the Notebook and Desktop users.

The six subjective ratings were provided on a scale of 1 (very unsatisfactory) to 6 (very satisfactory), with only those two anchor phrases on the scale (Figure 5). Again, the six dimensions were labeled "personal computers," "laptop/notebook computers," "Internet e-mail," "USAFA Intranet," "web browsing" and "the USAFA dial-in service."

The groups did not differ significantly with respect to their ratings of personal computers. The mode of the distribution was a rating of 5, with a range from 1 to 6. The groups did not differ significantly with respect to their ratings of laptop/notebook computers.

The mode of the distribution was a rating of 4.5, with a range from 1 to 6. There were 62 users in the notebook group and 13 users in the desktop group who provided ratings.

The groups did not differ significantly with respect to their ratings of e-mail. The mode of the distribution was a rating of 5, with a range from 1 to 6. There were 80 users in the notebook group and 23 users in the desktop group who provided ratings.

The groups differed significantly with respect to their ratings of the USAFA Intranet ($X^2 = 16.3$, df = 2, $p < 0.002$). The mode of the notebook group distribution was a rating of 5, with a range from 1 to 6. The mode of the desktop group distribution was a rating of 2, with a range from 1 to 5. There were 83 users in the notebook group and 22 users in the desktop group who provided ratings.

The groups did not differ significantly with respect to their ratings of web browsing. The mode of the distribution was a rating of 5, with a range from 1 to 6. There were 84 users in the notebook group and 23 users in the desktop group who provided ratings.

The groups did not differ significantly with respect to their ratings of the USAFA dial-in service. The mode of the distribution was a rating of 1, with a range from 1 to 6. There were 37 users in the notebook group and 9 users in the desktop group who provided ratings.

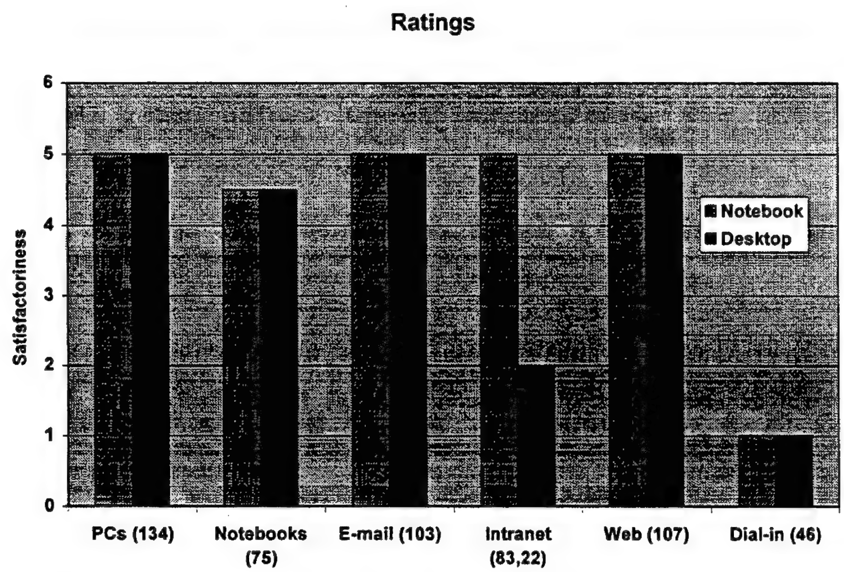

Figure 5. Subjective ratings of satisfactoriness (6 is high) for personal computers, notebook computers, e-mail, the USAFA Intranet, the World Wide Web, and the USAFA dial-in service. Figures in parentheses are sample size. The ratings for the Intranet differed between groups (see text).

Discussion

We hypothesized that the experimental and control groups would not differ with respect to age, military-civilian mix, gender, academic rank, military rank, and computer experience. These hypotheses were supported. The pooled mean age was about 37 yr and the pooled male-female ratio was about 81% to 19%. The pooled mode for academic rank was Assistant Professor and for military rank was O3 (Captain), with a secondary mode for civilian faculty.

The pooled mean for all computer experience was about 16 yr, for personal computer experience about 13 yr, and for notebook computer experience about 2.75 yr. The pooled mean for e-mail experience was about 6 yr, for Intranet experience about 2.5 yr, for Web experience about 3.7 yr, for USAFA dial-in experience about 0.75 yr, and for other dial-in experience about 2.5 yr.

While the mode of military rank and civilian-military mix (Figure 1) occurred at the level of O3 (Captain), the mode of the distribution of education level occurred at the doctoral level (Figure 4). This was somewhat interesting because most Captains on the faculty were known to be at the masters level. The secondary mode for civilian faculty (Figure 1) probably caused the education level mode to occur at the doctoral level. All civilian faculty are required to hold a doctoral level degree.

Generally, the two groups came into the project satisfied with various aspects of computer use. They rated the satisfactoriness of personal computers, notebook computers, e-mail and the Web rather highly (4.5 to 5 on a scale of 1 to 6). However, they rated the USAFA dial-in service as low as possible on the scale. This low rating may signal a problem that should be dealt with, especially for the Notebook group, as the project continues.

The two groups differed significantly with respect to their ratings of the satisfactoriness of the USAFA Intranet. The mode of the notebook group distribution was high (satisfactoriness = 5), while the mode of the desktop group distribution was low (satisfactoriness = 2). The reason for this difference was obscure. One may speculate that our users who acquired notebook computers were more likely to have had experience with other intranets and, thus, used a larger context for this particular rating. However, there were no data available to support or refute this speculation.

Two sets of data were missing from the Entry Survey: years teaching experience, and length of time at USAFA. These items will be covered on the Exit Survey.

The data acquired to date and to be acquired in this project should provide a statistical basis that may help identify potential applications of notebook computers across many Air Force and Department of Defense missions.

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Integrating Mathematica with PowerPoint

Frank C. Wilson, M.S., Captain, USAF
Department of Mathematical Sciences

Abstract: Mathematica is a powerful graphics generation tool, and PowerPoint is a powerful instructional delivery tool. By marrying the two products, difficult mathematical concepts may be presented graphically in a more understandable way. A sampling of PowerPoint slides using Mathematica graphics were presented along with an explanation of the graphics manipulation process.

Several examples of PowerPoint presentations developed for the Math 141 calculus course were demonstrated in a 10-15 minute presentation. Thirty-one PowerPoint presentations have been developed to support the Math 141 calculus course. In this presentation, the process of converting Mathematica graphs into PowerPoint objects was discussed. The method is detailed in the steps below.

Converting Mathematica Graphs to PowerPoint Objects

Copy the graphic in Mathematica

Click on the graphic and press "Ctrl-C"

Paste the graphic in PowerPoint

Press "Ctrl-v" to paste the graphic in an open slide.

Size the graphic

Click on the handles and drag to the desired dimension.

Convert the graphic to a Microsoft Office drawing

Double-click the image and select "Yes" (This makes each element of the graph a modifiable object.)

If the font/line color of the graph is similar in color to the slide background, change the font and line color to a contrasting color

On the drawing toolbar, click the arrow next to paintbrush icon and select a color. (This changes the line color.)

On the drawing toolbar, click the arrow next to "A" icon and select a color. (This changes the line color.)

Remove the white background of the graph.

Click on the slide background. (This deselects all selected objects.)

Click on the white space of the graph

Press the Delete Key

Repeat the above delete sequence two more times.

Group the x-axis labels

Hold the Shift Key down and mouse click on each label

Click Draw on the drawing toolbar and select Group. (This groups the labels)

Group the y-axis labels

Hold the Shift Key down and mouse click on each label

Click Draw on the drawing toolbar and select Group. (This groups the labels)

Remove the line border from the x- and y-axis labels

Hold the Shift Key down click on an x-axis label and a y-axis label

On the drawing toolbar, click the arrow next to paintbrush icon and scroll to No Line. (This makes the line invisible.)

If necessary, adjust the position of the x- and y-axis labels

Click on the appropriate label group

Use the arrow keys to adjust the label position

Increase the width of the x- and y- axis

Hold the Shift Key down click on the x-axis and the y-axis

On the drawing toolbar, click on the line thickness icon (three lines of different widths are on the face of the icon).

Scroll to 1½ pt (This changes the line width to 1½ pt)

Change the line width/color of the plot of the function

Click on the plot of the function

On the drawing toolbar, click on the line thickness icon (three lines of different widths are on the face of the icon).

Scroll to 3 pt (This changes the line width to 3 pt)

On the drawing toolbar, click the arrow next to paintbrush icon and scroll to the desired line color. (This makes the line invisible.)

If you have multiple plots, repeat the above steps for each plot.

If desired, label plots with PowerPoint text box.

Animating PowerPoint Objects

Right-click on the object you want to animate.
Scroll to Custom Animation
In the Custom Animation dialog box, click on the arrow next to No Effect.
Scroll down to the desired animation effect. (Wipe Right works well.)
Click the Preview button to see the effect.
Click the OK button when you're satisfied with the animation effect.

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ASSESSMENT

Developing a Role for Students in Higher Education Outcomes Assessment: Self Study Committee Participation (Panel)

Anthony J. Aretz, Ph.D., Lt Colonel, USAF
Department of Behavioral Sciences and Leadership

Panel members: C2C Lindsay L. Winter, C2C Andrew J. Nutz, C2C Laura C. Terry, and C2C Reed W. Wangerud
Department of Behavioral Sciences and Leadership

Abstract: A unique aspect of the NCA Self Study Subcommittee, which was tasked with determining whether or not the Academy was accomplishing its educational and other purposes, was its inclusion of four second class cadets as full fledged members of the committee for the fall semester of 1998. The cadets' contributions to the committee process and report were both positive and substantial. The role of this participation in the cadets' development also appears to have been very beneficial. Each cadet panel member described what they did and told what they learned about themselves, their institution and their own education.

A unique aspect of the NCA Self Study Subcommittee tasked with determining whether or not the Academy was accomplishing its educational and other purposes was its inclusion of four second class cadets as full fledged members of the committee for the fall semester of 1998. The cadets' contributions to the committee process and report were both positive and substantial. The role of this participation in the cadets' development also appears to have been very beneficial.

Cadets, nominated by existing subcommittee members, were given the opportunity to enroll in Behavioral Sciences 495, Educational Outcomes Assessment Practicum, during the fall semester of 1998. The course was 1.5 semester hours and DFR assisted in making scheduling arrangements so cadets could attend weekly committee meetings. Initial meetings were devoted to defining the committee's task and organizing our resources to accomplish it within necessary time constraints. When it became clear that further progress would require the 25-person subcommittee would need to divide itself into 4 to 5 person teams to look at particular sets of data or reports, the cadets each became members of separate subcommittees. When each subcommittee had completed its tasks, the group met again as a whole. Each group presented its findings; other members of the subcommittee questioned, criticized and critiqued the presentations. Throughout this process, cadets' perspectives and insights helped provide a reality check for faculty and staff members' conjectures and interpretations.

The cadets' progress report was based upon brief written reports describing what they had done thus far, how it related to the NCA question of whether or not the institution was accomplishing its educational and other purposes, and what they had learned thus far. Copies of these reports were distributed to about a dozen other members of the committee for their review and critique. Cadets received these inputs and used them to prepare their final reports on their participation on the committee. These reports were included as an attachment to the NCA Self Study.

Each cadet panel member briefly introduced her/himself, described what they did, and told what they learned about themselves, their institution and their own education.

C2C Lindsay Winter

I participated in Lt. Colonel Anne Campbell's small group. We were assigned to look over the 1998 Graduation Survey and draw conclusions from the data. I was specifically assigned to the questions that involved the Athletics Department (AH). I looked at each question's responses and tried to find trends in the data. I broke my results down into four categories: commitment to physical fitness, leadership skills and development, moral development, and pride in athletic accomplishments. I found negative results in all four areas of AH. As a result, I tried to come up with some ideas to help improve these areas of athletics.

During this process I learned several interesting things about myself. I realized how easily I can lose my assertiveness and become intimidated when surrounded by high ranking officers. I also spent lots of time searching for solutions to some of the problem areas I discovered in my research. I realized how hard it is to find solutions to many of the issues I encountered. I also realized how cadet attitudes are a large portion of the problems that I was attempting to solve. I also learned several interesting things about my institution and education through this class.

After all my years in school, I never realized how much time went into assessment and on top of that the process of becoming an accredited university. I thought it was great to see how involved the faculty was, and disheartening to see how many refused to help us achieve our goal by providing us feedback. The opportunity to be a part of this small group was very valuable to me. It gave me an appreciation for the hard work that teachers have to do outside of the classroom. This is an area that greatly interests me because I hope to come back to the Academy and teach someday.

C2C Andrew Nutz

During the conference on assessment in education, I participated on a student panel that provided my fellow cadets and I the opportunity to express our points of view on the Academy's self-study for the North Central Association's (Chapter 5, Criterion 3). During the student panel, I provided details of my participation with the committee as well as with my sub-committee assigned to examine miscellaneous archival objective data. I gave my opinion on the importance of the self-study and assessment processes and I fielded a handful of questions from the guests, mainly directed toward my experience.

A major point that was debated at the conference was the fact that, although the Academy uses numerous evaluation tools to gather significant data from a variety of sources using many different methods, the Academy does not yet have a comprehensive and systematic process for disseminating data and analyses back to decision-makers. In addition, it was evident during the conference that the Air Force Academy places great importance on evaluating mission accomplishment and expends a great deal of effort gathering data.

One of the main points that I addressed was that it is not "looking good" for an outsider that matters, but the opportunities and recommendations for improvement that can be made. In addition, I found that the accreditation process allows the Air Force Academy and other institutions of higher learning the opportunity to determine whether or not they are accomplishing their educational and other outcomes. Finally, I believe that accreditation is in place for institutions to evaluate themselves and to gather feedback as to how they can

continuously improve. My overall experience was a good one, during which I learned a great deal about the process of assessment, as well as about myself.

C2C Laura Terry

By participating on the NCA assessment committee, I learned a great deal, not limited to only the realm of assessment. This brief exposure opened my eyes to the limited perspective I had concerning what goes on at the school.

I worked on the sub-committee that looked at which relevant data could be obtained from surveys returned by graduates and their supervisors. I was especially interested in several responses by graduates that showed concern as to whether the survey would ever be used to change anything. This reflects a common attitude fearing the seeming lack of action taken based on cadets' responses. Our group found that in some cases, we need to make sure that the assessment process is completed by ensuring that decision makers understand and use the data collected.

As cadets, our presence on the committee helped to remind everyone of the main focus of this institution, namely the development of officer candidates. I cannot claim that this particular group was guilty of ignoring this fact, but I am certain that the idea would be useful for other groups around the Academy.

I was given an unusual opportunity in working with this committee. As students we rarely get to observe our instructors working in a group together, let alone being a part of the group. There are many people here who care about providing the best education possible and seek to make the necessary changes. Many good programs are in place for collecting data. In some cases, we need to make sure that the assessment process is completed by ensuring that decision makers understand and use the data collected. To be aware of this perspective, while actually submersed in the system, is a uniquely valuable experience.

United States Air Force Academy Accreditation Self-Study Subcommittee on Assessment
"Is The Air Force Academy Accomplishing It's Mission?" (Panel)

Larry A. Smith, M.A, Colonel, USAF
34th Education Group

Panel Members: Major John Putnam (Dept of Biology), Lt Col Anne Campbell (Dept of Political Science), Major Julie Chesley (Dept of Management)

Abstract: The panel addressed the question of whether or not the Air Force Academy is accomplishing its educational and other purposes. The discussion was based on the work of a subcommittee of the North Central Association Self Study Committee. This committee worked together for nearly a year and collected a wide array of data and reports concerning the Academy's educational efficacy.

Background

The Air Force Academy is undergoing reaccreditation by the North Central Association (NCA). A significant part of that process is preparing a self-study that details how well the institution is accomplishing its stated objectives. One chapter of the study specifically examines the assessment process used to determine whether or not the Academy mission is being accomplished. The Assessment Subcommittee was tasked to write that chapter. The panel, selected members from the Assessment Subcommittee, discussed the methodology involved and the general findings that resulted.

Subcommittee Composition

The committee was co-chaired by Colonel David Porter from the academic arena and Colonel Larry Smith from the military mission area. Experts from every Academy mission area as well as cadets from the student body were represented on the committee.

Committee Process

The committee reviewed existing data collection instruments, examined collected data, performed gap analysis and conducted some independent research in the areas where gaps existed. A report detailing this data was compiled and sent to various decision makers across the Academy for comment. The committee then evaluated the data including decision maker comments and drafted their findings into the self-study assessment chapter. The chapter was submitted to the Academy Accreditation Committee which is incorporating it into the final self-study.

The assessment committee enlisted cadets to help evaluated the Academy's mission effectiveness. Top cadets from various majors volunteered to help with the committee process. They served on various sub groups and wrote a paper on their experiences with the process. In addition, they made a presentation to the PPIER Symposium outlining what they had learned. To a person, the cadets significantly valued their chance to participate in the accreditation process. For their effort, the cadets received academic credit for an independent study course.

General Findings

The Academy uses many varied instruments to collect a great deal of data, and Academy leaders use the data to make decisions. Furthermore, since the Academy's graduates initially work for the same employer unique possibilities exist for follow up data from the graduate and graduate supervisor/peer surveys the institution accomplishes. This data tells Academy faculty and staff how well they meet the needs of Air Force leadership. However, the committee also found no central feedback process existed to help make the system more responsive.

Assessment in Higher Education: Is It Making a Difference? (Panel)

Randall J. Stiles, Ph.D., Colonel, USAF
Director of Education

Panel members: Dr. Libby Rittenberg (Department of Economics, Colorado College), Dr. Robert Durham (Department of Psychology, University of Colorado, Colorado Springs), Dr. Donald Bird, (Department of Chemistry), Mr. David Fitzkee, (Department of Law)

Abstract: The decade of the 90s has brought with it a dramatic increase in emphasis on assessment of student academic achievement at both the K-12 and higher education levels. All colleges, universities, and specialized institutions seeking NCA accreditation have been required to invest heavily in the development and implementation of assessment programs. During this session, a panel of educators and assessment specialists from the Pikes Peak region discussed their work on assessment as well as their opinions about progress being made.

"…assessing student academic achievement is an essential component of evaluating overall institutional effectiveness. While the Commission understands that the measurement of learning outcomes is only one aspect of a total, effective educational program, it recognizes that assessment data contribute to successful decision-making within an institution, particularly in curriculum and faculty development.

"The Commission's expectation that institutions have effective programs to assess student achievement is now embedded in its Criteria for Accreditation: "The institution is accomplishing its educational and other purposes" (Criterion Three) and "The institution can continue to accomplish its purposes and strengthen its educational effectiveness" (Criterion Four). The patterns of evidence for these criteria illustrate the centrality of an effective assessment program in documenting the effectiveness of an institution's educational programs and the institution's commitment and capacity to strengthen those programs."

North Central Association (NCA)
Handbook of Accreditation, 1997

The decade of the 90s brought with it a dramatic increase in emphasis on assessment of student achievement at both the K-12 and higher-education levels. The quote above from the NCA's Handbook of Accreditation illustrates the seriousness of this change; institutional accreditation is now contingent upon successful implementation of an assessment program. The Air Force Academy, like nearly all other higher-education institutions, has invested considerable time, energy, and money in assessment. Following is a brief summary of major initiatives at the Academy since 1992 that illustrates the magnitude of our investment.

We began by seeking the advice of a number of nationally eminent experts in the academic assessment field including Dr. Richard Light, Director of the Harvard Assessment Seminars; Dr. Jim Nichols, a nationally-known figure in implementing assessment programs; various faculty from Alverno College, universally considered an assessment "showcase"; and Dr. Peter Ewell, a seminal authority on assessment in the American Association of Higher Education. Also in 1992, the Superintendent assembled a team of Academy representatives and senior Air Force officers to create new vision and mission statements for the Academy. It was during this period that consensus was reached on the Academy's core values: integrity

first, service before self, and excellence in all we do. Within the faculty, the Dean commissioned a group of senior faculty members to draft desired outcomes of the academic program at USAFA. In 1995, in response to a requirement from NCA, we developed a plan for assessing the academic achievement of cadets at the Academy. The plan was structured around the educational outcomes.

Our assessment work was not limited to the domain of academics. Early in the 1990s, the Air Force Chief of Staff initiated a program known as Quality Air Force. Derived from Total Quality Management principles, this program led to an assessment and reporting process called Unit Self Assessment (USA). By the middle of the decade, each major Air Force organization was creating USA reports. The Air Force Academy completed this task in 1995. The format for the report followed the Malcolm E. Baldrige criteria and so the process of information gathering and reporting, in many ways, was similar to the NCA self study.

After creating the NCA Assessment Plan and completing the institutional USA, several teams were formed within the faculty that constituted an Educational Outcomes Assessment Working Group (EOAWG). This group explored an assessment philosophy and techniques that would be well-suited for our educational outcomes. Finally, during the last several years, the Dean decentralized assessment responsibility to the department level and each department has written a unit self assessment report. Most recently, a group within the faculty has created a catalog of assessment techniques that are currently in use at the Academy. Every academic department is represented and the catalog contains more than 370 entries. The Directorate of Education (DFE) continues to provide assessment support through focus groups, Small Group Instructional Diagnostics (SGIDs), and expert consulting services when requested.

We have learned a number of lessons from this work. Some of the more important ones are[11]:

1. It is not likely that there is a "best" way to assess an educational outcome. When dealing with complex psychoeducational issues, we must rely on multiple techniques and look for patterns of convergence in the data.
2. There is often an inverse relationship between the quality of assessment methods and their expediency; preferred methods usually cost more and take longer to complete.
3. It is difficult to transfer assessment techniques from one context to another; the only way to be certain it works in your program with your students is trial and error.

In summary, we emphasize three points: 1) assessment programs have received a dramatic increase in attention during the past decade, 2) most higher-education institutions have invested heavily to develop successful programs, and 3) academic assessment has proven to be complex and "expensive" work. Is this investment making a difference?

To address this question, we assembled a panel of four faculty members with assessment expertise. They were Dr. Robert Durham, a psychology professor at CU-the Springs, Dr. Libby Rittenberg, an economics professor at Colorado College, Dr. Don Bird, a chemistry professor at the Academy, and Mr. Dave Fitzke, a professor of Law, also from the Academy. All four of these people have been responsible for institutional and/or department-level assessment activities at their respective institutions. The following questions were used to structure the panel discussion:

[11] These lessons are adapted from "A Critical Review of Student Assessment Options", by Joseph Prus and Reid Johnson, Winthrop College, 1992.

- How do you define assessment?
  - The language of assessment is complex and seems to be subject to differing interpretations depending on the disciplinary background of the practitioner. How might we converge on a common understanding of assessment concepts?
  - Is there a difference between your concept of "assessment" and "measurement"?
- Can you give an example (or two) of effective assessment practice?
  - How would you define "effective"?
  - How much did it cost (time, manpower, $)
  - Can you cite examples of decisions that were significantly informed by assessment data?
  - How can we transfer best practices from one context to another?
- Can you give an example of a poor assessment initiative you have seen or experienced?
  - Why was it ineffective?
  - How can we learn from our assessment "failures"?
- Is the increased emphasis on assessment of student academic achievement making a difference in higher-education?
  - Are learning and teaching better at your institution than a decade ago? How do you know?
  - To what degree has any change been the result of assessment initiatives?

It is not possible to capture the rich content of the discussion in this short synopsis. However, the discussion did make it clear that our understanding of assessment is still developing and that all three of the institutions represented on the panel have examples of success as well as some growing pains in their assessment work. Is assessment of student academic achievement making a difference in higher education? I think the consensus of the panel was clearly "yes". However, it is work filled with all the complexities of social science: many variables, with unclear causal relationships among those variables; dynamic, organic, multi-level systems; and a high degree of uncertainty in measurement. As we continue to refine our assessment practices, we should remember the words of Aristotle who said: "Our treatment will be adequate if we make it as precise as the subject matter allows. The same degree of accuracy should not be demanded in all inquiries…" In spite of these challenges, assessment of student academic achievement is a worthy and necessary endeavor. Einstein said, "Not everything that counts can be counted, and not everything that can be counted counts". It may never be possible to "count" some important dimensions of student academic achievement. However, if our inquiry results in an active dialogue about important issues and an improved understanding of those issues, then we will have succeeded.

Using Myers-Briggs with Hands-on and Visualization to Improve Engineering Mechanics Courses

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Robert Q. Borchert, M.S., Captain, USAF
Department of Engineering Mechanics

David Yates, Ph.D.
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Abstract: The paper reports the development and assessment of three techniques used to enhance learning in the core engineering mechanics course here at the USAF Academy. The three techniques are: (1) real world industrial based applications designed to increase student motivation, (2) interactive multimedia computer visualizations, and (3) hands-on demonstrations and experiments. Through the use of three different types of assessment techniques, coordinated with students' Myers-Briggs and VARK learning styles types, we have arrived at a variety of conclusions which are described.

Introduction

Engineering mechanics education is undergoing a transformation from strictly lecture-based education to a format where a variety of innovative learning techniques are used. This transformation has been spurred on by a renewed understanding that the abstract concepts inherent in engineering mechanics may not be learned effectively in a predominantly lecture based environment. Both new tools for enhancing student learning as well as concrete data establishing the effectiveness of these tools are needed. This paper builds on previous work using innovative teaching tools [1-8,1-15,19,20,24] by developing and assessing our current use of two tools: computer based visualizations and hands on demonstrations and experiments. These tools are being used in our Fall 1998 Engineering Mechanics core course which is taken by all cadets regardless of their major.

Evaluation of the enhancement in student learning, brought about by use of the hands-on and visualization tools, has been accomplished by a variety of assessment techniques including scores on quick quizzes taken before and after the enhancement tool and daily detailed student feedback. The daily student feedback was done using a survey which took the students approximately a minute to complete after each lecture. The survey was designed to differentiate among four things: 1) student's interest in that lecture's subject matter; 2) that day's learning experience; 3) student's ability to apply material covered that day; and 4) student's interest in exploring that lecture's material further. The quick quizzes are designed to measure conceptual understanding of certain abstract stress oriented concepts. The hands-on tools are low-cost, interactive experiments designed to enhance understanding of specific abstract concepts. The visualization content consists of finite element based stress results displayed in color formats. Both the hands-on and the visualization tools are designed to emphasize aspects of stress analysis which our students have traditionally found difficult to grasp. The results from the surveys and quick quizzes are correlated with the student's Myers-Briggs Type Indicator (MBTI).

Hands-on Content

The hands-on content for the study involved use of the "student opticon" and the "micro torsion tester" shown below (Figures 1 and 2). The student opticon device is composed of two polarizing filters and a birefringent photoelastic material beam or load cell mounted in a wooden box. Students push on the beam or load cell with their fingers to produce color patterns corresponding to changes in the magnitude of maximum shear stress in the specimen. The device also enables visualization of stress distribution. Materials for the device cost about $30.

The hand-held micro torsion tester, in combination with two small polarizing filters, allows the student to apply torque to a circular cross section and see the resulting stress distribution. It is constructed of a circular wafer of birefringent photoelastic material centrally sandwiched with clear adhesive between two pieces of clear 1/8 inch thick Plexiglas. The Plexiglas pieces are cut with a circular central section and two lever arms extending in opposite directions. When the components are bonded, the upper and lower Plexiglas lever arms are offset from each other about 20° so that the student may squeeze on the two sets of opposing arms to produce pure torque in the photoelastic wafer. When students applied torque to the device, the color patterns indicating changes in maximum shear stress were slightly distorted due to bonding imperfections. However, the concentric distribution of shear stress over the cross section was still apparent.

Figure 1. Student Opticon.

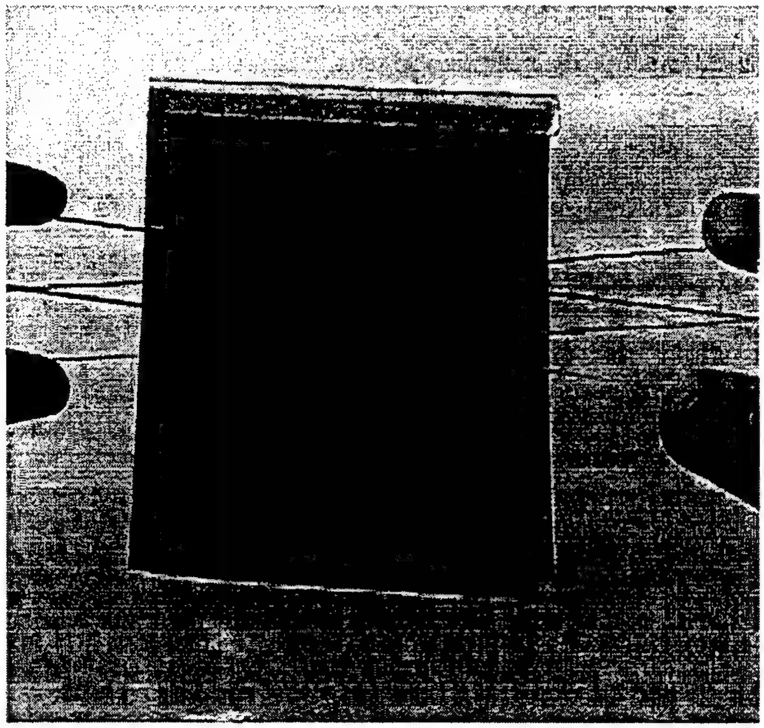
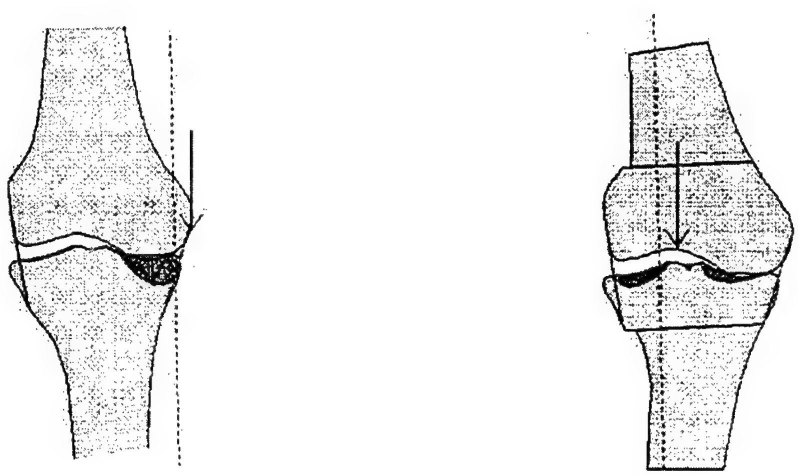


Figure 2. Micro Torsion Tester.

Visualization Content

Visualization content for each module involved several slides showing finite element based color stress plots illustrating various concepts from stress analysis. Real world examples were used as the context for the visualization. These examples entailed brief



Pre-operative Loading **Post-operative Loading**

Figure 3. Pre- and post-operative loading of a knee joint.

overviews of how torsion, bending, and combined loading applied to the cases of turbine shafts, aircraft wings, and human knee joints respectively. For example, Figure 3 was one of the slides used to illustrate a knee operation which was proposed to change combined axial and bending loading of a knee joint to pure axial loading aligned with the mechanical axis of the bone [16]. This real world example was followed by a series of finite element based stress plots showing various concepts intrinsic to combined loading.

Another example utilized the illustration shown in Figure 4 where the distribution of bending stress through an F-16 wing cross-section was roughly approximated with a beam model.

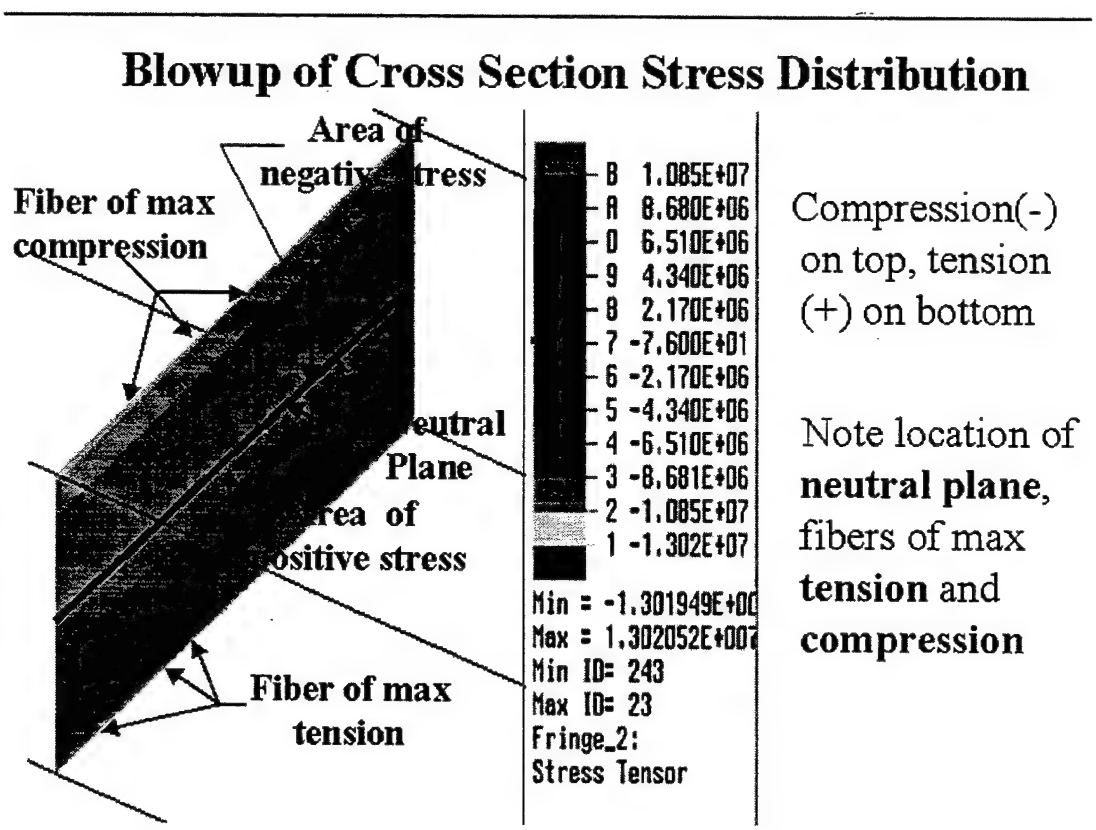


Figure 4. Visualization of normal stresses due to bending.

The One Minute Survey (OMS)

The one minute survey (OMS) being used in the current course has been iteratively developed over the last three semesters. The original OMS used for a previous study [Jensen2] asked only for MBTI type and overall lecture rating. In order to gain additional insight into the effectiveness of the modules, a refined OMS was developed and used for the present study. The refined version requests information about the students' perception of interest, learning, applicability and motivation for future exploration (see Fig 5). In addition, the MBTI type is recorded. This OMS was given after each lecture and took about a minute for students to complete. Figure 5 shows the content and form.

1 MINUTE SURVEY EM120 - FALL 1998
Lesson #: _____
MBTI Type: _______ VARK Type: _______
Please rate the following statements on a scale from 1 to 10 (1 - very untrue; 10 - very true):
___ 1. Today's class kept me interested.
___ 2. Today's class was a good learning experience.
___ 3. This class prepared me well to apply today's concepts to problems.
___ 4. This class motivated me to further explore today's concepts.

Figure 5. One minute survey form.

Table 1. Number of standard deviations off mean (percentile) for question number and type.

1 min. Survey Question	S-TYPE	N-TYPE
Q1:	-0.29	0.12
Lecture was interesting?	(39)	(55)
Q2:	-0.22	0.49
Lecture helped me learn?	(41)	(69)
Q3:	0.00	0.16
Lecture helped me to apply material?	(50)	(56)
Q4:	-0.88	-0.22
Lecture motivated me to explore subject further?	(19)	(41)

As can be seen in Table 1, N-types rate the module-based lectures higher than do the S-types for each of the four questions from the OMS. This is not an expected result [8-10, 13, 17,18, 21-23, 25]. In previous studies with hands-on content [Jensen2,4], the S-types have responded more favorably than N-types to the modules. In this case, however, we believe that the response from the S and N-types is reversed because the module-based content required the students to abstractly apply the content contained in the modules. This is due to the fact

that the modules were used to help introduce ***new*** material, which the students knew they would need to be able to use to solve problems. The abstract process of using sensory information to formulate problem solving strategies, is a process which the N-types would view more favorably than would the S-types.

Results from Quick Quizzes

Immediately before and after the enhanced learning modules were presented, a conceptual quick quiz was administered to measure short-term increase in understanding as a result of the module. The results of the quick quizzes were compiled for S-type and N-type preferences, and for all students without regard for differences. Table 2 shows the improvement in the percentage of correct answers on the quiz questions as a result of the material presented in class.

Table 2. Measured quick quiz improvement.

Quick Quiz Question		S	N	All
Torsion	#1	20.0%	7.7%	14.3%
	#2	20.9%	3.5%	13.4%
Bending	#1	20.0%	15.0%	23.1%
	#2	32.0%	30.0%	32.7%
Combined Loading	#1	24.1%	25.0%	32.8%
	#2	41.4%	25.0%	32.8%
Average		**26.4%**	**17.7%**	**24.9%**

Although a rigorous statistical analysis would have to be conducted to ensure statistical significance, it does seem apparent that the enhanced learning modules do provide additional benefit to the S-type students compared to the N-types and the general population when looking at the average results. One might expect the hands-on content to help these students the most. For the S-type students, the greatest benefit, when compared with the "all" category, was found in the torsion and combined loading modules. The N-type students almost always showed lower rates of improvement.

Conclusions

The present work has focused on developing and assessing two learning enhancement tools: computer based visualizations and hands on demonstrations and experiments. These tools were used in our Fall 1998 Engineering Mechanics core course which is taken by all cadets regardless of their major. Assessment has been accomplished by use of two techniques: 1) scores on quick quizzes taken before and after the enhancement tool and 2) daily detailed student feedback. The daily student feedback used a survey which took the students approximately a minute to complete after each lecture. The survey asked for feedback in four specific areas for each lecture: 1) student's interest in that lecture's subject matter; 2) that day's learning experience; 3) student's ability to apply material covered that day; and 4) student's interest in exploring that lecture's material further. The quick quizzes were designed to measure conceptual understanding of certain abstract stress oriented concepts.

The hands-on devices are low-cost, interactive experiments designed to enhance understanding of specific abstract concepts. The visualization content consists of finite element-based stress results displayed in color formats.

The results from the surveys and quick quizzes were correlated with the student's Myers Briggs Type Indicator (MBTI). A variety of results were obtained using the two assessment instruments. From the surveys, students indicated that the hands-on and visual content overall was interesting, enhanced the learning experience and helped them to solve problems. However, the majority of students did not find that the module-based lectures motivated them to explore the day's content further. Surveys further indicated that the module-based content was rated highly by the MBTI "N" type students, but not so highly by the MBTI "S" types. Although this runs contrary to what was expected, our conjecture is that the N-types prefer this content (and S-types do not) because the manner in which it was presented necessitated that the conceptual content be abstractly applied to solve problems.

The quick quiz gives indication of the short term gain in problem solving skills. Results from the quick quizzes indicate that the S-types achieve more benefit than the average student or the N-types from the module-based content. However, larger data sets would be needed in order to ensure accuracy of this particular result.

Overall, we believe that the project provided a solid foundation in terms of development of content and assessment strategies. Significantly more work needs to be done in order to obtain modules and assessment results which have been definitively shown to enhance students learning. Continuation of this work is planned. Others are welcome to use our modules or assessment results in any way they feel is appropriate. To obtain these resources, simply contact one of the authors.

This work was sponsored in part by the Air Force Office of Scientific Research and by NSF under contract DUE-9751315.

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Using Learning Style Data in an Introductory Computer Science Course

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Abstract: Because cognitive learning styles affect how students approach new material, a deeper comprehension of these styles can help faculty enhance student learning experiences. In this paper we discuss how learning style data can be used to help guide student study habits and instructional strategies. Using the Group Embedded Figures Test, Felder's Index of Learning Styles, Kolb's Learning Styles Inventory II '85, and the Kerisey Temperament Sorter, we examine whether or not there is a correlation between learning style and academic performance in an introductory computer science course.

Introduction

A student's learning style indicates how that student responds to a wide range of intellectual and perceptual stimuli and how they prefer to approach new material. For example, some students may prefer to discuss new concepts in small groups, while others may prefer solitary study of those concepts. A student's learning style can therefore be used to guide the student to the study techniques that are most likely to be effective for them.

We can also use learning style data to help improve instructor presentations. For example, instructors may have an instructional strategy they use consistently that interferes with a particular learning style, causing students with that learning style to perform less proficiently than other students. We can then use this information to suggest alternative delivery methodologies to the instructor to help them reach those students.

Additionally, research has shown that there is very little relationship between overall college achievement and learning style [6], yet there are some indications that there is a relationship between learning style and performance in specific subject areas. For example, Moldafsky found that learning style could affect an individual's skill in information processing, decision-making attitudes toward computers, and computer anxiety [4]. We therefore hypothesize that learning style may affect student performance in particular courses.

All students attending the U.S. Air Force Academy (USAFA) are required to take an introductory course in computer science (CompSci 110). Because the course is taken by all students in either their freshman or sophomore year, it assumes no prior knowledge about computers. The course has been designed to cover four basic areas of study, but the key topic is problem solving with computers. Since students need to know how to solve problems before they can solve them using computers, we start by helping the students develop their problem solving skills. They then learn how to use these skills to solve problems using computers and the Ada programming language.

Last year we conducted an experiment on 877 students enrolled in an introductory course in computer science, using 4 different learning styles instruments to collect learning style data on those students. We then used this learning style data to recommend suitable study habits for those students. We also evaluated (for each instructor) the impact of the various learning styles on 8 measures of course performance. For half of the instructors, we found a sufficiently large number of statistically significant results to indicate that discussion

Visual and Verbal Learners
Visual learners retain more from things they see - pictures, diagrams, flow charts, etc. Verbal learners get more out of words - written and spoken explanations. If you're a visual learner, it might help to diagram your problem solutions to check them before coding. It could also help if you draw a picture of each Ada construct you learn. If you're a verbal learner, writing the required English algorithm for each problem solution may be sufficient for you to check your work.

Figure 1. Learning Styles Reading Excerpt

of instructional strategies is merited; we are currently holding those discussions with the instructors. Finally, we conducted course-wide statistical analysis to determine the impact of learning style on performance in this course, and found numerous statistically significant results.

Guiding Study Habits

One of the uses for our learning styles data involves guiding student study habits based on that data. To help provide this guidance, we supplied each student with a brief (3 pages) reading that discusses each of the learning style models and relates different learning styles to the approach they should take toward the material in CompSci 110. Students can then use this reading in conjunction with their learning styles instrument results to select their study habits appropriately.

For example, one of the dimensions measured by Felder's ILS is the visual/verbal dimension. In Figure 1, we provide the corresponding excerpt from the reading provided to the students. If students find that they tend toward visual learning, they can use this information to help guide their study of Ada constructs. We teach them how to use control flow graphs (a flowchart-like representation) to graphically depict various Ada constructs, such as selection and iteration constructs, and a visual learner might therefore find it easier to use these graphs as they try to understand the constructs. Alternatively, verbal learners may find that using this graphical representation is not particularly helpful. These students may choose to use syntax boxes for the constructs or textual examples to help them understand those constructs.

Instructor-Specific Results

We can also use learning style data to help instructors improve their instructional techniques. For instance, if an instructor uses an instructional strategy that interferes with a particular learning style, students with that learning style may exhibit poor performance in the course. If analysis of the learning style data indicates this to be true, the instructor can modify their instructional strategies to also reach those students.

To see how we can use this information, consider one instructor's results for Felder's Active/Reflective dimension. The correlations for this instructor are positive, relatively strong (0.42 and higher), and statistically significant for 5 of the response variables, indicating that active learners tend to do better in this instructor's class than reflective learners. We can then use this information to suggest that the instructor build more "reflection" time into his lectures, trying to reach a better balance of active group or board work and individual work.

Conclusions

Because learning style affects how a student responds to stimuli and approaches new material, there are a number of ways we can use learning style data to enhance that student's

learning experience. We can use learning style data to guide the student toward more effective study habits and we can use that data to help instructors in their selection of instructional strategies.

We are continuing this work with the students currently enrolled in CompSci 110. Administering the learning style instruments takes a reasonably small amount of time (typically an hour or so), and the resulting data can be used to help students develop their study habits, to help instructors select their instructional strategies more effectively, and to help researchers better understand how different learning styles can affect student performance.

For a detailed description of the Learning Style Instruments and details of the statistical analyses accomplished, please see the researchers for a more extensive written summary of the work.

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Benefit Assessment of Classroom Experimental Economics

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Abstract: We examined, using pre- and post-test scores, the differences in student performance in economics when cadets were taught using two different teaching methods. In addition, we examined the theoretical pitfalls associated with using pre- and post-test data without careful thought. In addition to these results, we examined student attitudinal data in which the experimental approach to teaching economics is preferred.

Introduction

In pursuit of the ever illusive perfect pedagogical technique for imparting knowledge to our charges, many of us in the economics profession try classroom exercises and demonstrations, both to keep our students' attention and to demonstrate that there may be a certain element of validity to what we are saying.

Many of these demonstrations have been passed by word of mouth from generation to generation of instructor or adapted from experiments performed in a laboratory setting. Recently, however, some consolidated sources for using experiments in economic principles classes have appeared. Most notably, the classroom experiment book by Bergstrom and Miller. With the expanding pool of resources for classroom experiments in economics, an examination of the pedagogical value of these experiments on student performance is in order. Yet, surprisingly little research has been done in this area. It has been claimed for years that there is significant added value in interactive learning. Yet, even in the education literature, there has been surprisingly paltry examination of empirical evidence, particular in the area of comparing the performance between two instructional techniques in terms of added cognitive value. A definitive answer cannot convincingly be given without closer examination.

Recently the introductory economics curriculum at USAFA made a transition to an experiment-based approach to teaching. In doing so, we conducted pre- and post-testing on the students who were randomly selected to be taught using either the experiment-based approach or a traditional lecture methodology. We are currently in the process of examining the differences in student performance between the two teaching techniques, if any. In addition to the performance data, we have data on student demographics and previous academic performance measures. Also, we have data on student attitudes toward the different course that can be used for comparison in that light.

In addition to examining the data itself, we examine issues involved in assessment of added value with respect to test score comparison. Many of the issues we bring up have simply been ignored in previous literature on assessment, potentially invalidating much of the previous research in this area. Simple statistical techniques can be used to correct the problems present in previous examination of this kind of information.

Preliminary results indicate a significant added value to student knowledge using both teaching techniques. Each methodology seems to have its own area of comparative advantage. Results such as this can easily be used to further refine economics courses in the future in order to take advantage of each teaching method's strengths.

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MISCELLANEOUS

Preparing Your Research Protocol for the Human Subjects Review Panel: Taking Advantage of the Shortcuts and Avoiding the Pitfalls (Workshop)

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This workshop was intended for individuals who perform or supervise behavioral, physiological or clinical research involving human subjects. The workshop recognized the need of the researcher to navigate through the human subjects review process as quickly and efficiently as possible. Emphasis was placed on educating researchers on the federal requirements for the protection of human subjects in research, describing the USAFA Institutional Review Board process, describing shortcuts to speed the review process, describing pitfalls that typically delay research approval, and addressing questions frequently encountered from researchers. The goal was to provide workshop attendees with practical information on how to complete requirements for human subjects review of their research.

Institutional Review Board

- The IRB is charged to protect the rights and welfare of human subjects in research
  - Authority and requirements for USAFA IRB derive from Federal law, DoD & AF policy
  - IRB has the authority to approve, require modifications or disapprove human research
  - Approved research is subject to continuing and annual IRB review
- The administrative agent for the USAFA IRB is USAFA/XPR

The IRB Process

- Principal investigator (PI) prepares package using protocol outline and informed consent document template
- PI submits for department coordination
- Preliminary review by IRB Administrator (USAFA/XPR)
- IRB review
- PI completes modifications, if required
- Approval by USAFA/CV
- Approval by HQ AFMOA
- Begin data collection!

IRB Review Process

- Protocols distributed to IRB before meeting
  - PI may be contacted by reviewers with questions and requests for clarification
- Protocol summarized at IRB meeting followed by discussion and vote
  - Protocol may be approved, approved with modification or disapproved
- Board meetings are open and PIs are encouraged, but not required, to attend

Criteria for IRB Research Review

- Risks to subjects are minimized by using sound research design
- Risks to subjects are reasonable in relation to anticipated benefits to subjects and the importance of the knowledge to be gained
- Selection of subjects is equitable
- Informed consent is sought and documented
- Research provides adequate provisions for safety of subjects and monitoring of data
- Research provides adequate provisions to protect the privacy of subjects and maintain confidentiality of data
- Safeguards are in place to protect the rights and welfare of "vulnerable" research populations

Informed Consent

- Assures that subjects understand the nature of the research and can knowledgeably and voluntarily decide to participate
- Cadets present a "doubly" vulnerable research population; subject to undue influence as:
  - Student: Student-teacher relationship, grades, competitive selection
  - Military member: Cadet-officer influences, upperclass-underclass influences, class loyalty

Criteria for Informed Consent Review

- Description of study: Purpose, duration, procedures, compensation/costs
- Description of risks: Reasonably foreseeable risks, discomforts
- Description of benefits: Direct benefits to subject
- Disclosure of alternatives: Same benefits/treatments available elsewhere?
- Extent of confidentiality: How will data be protected?
- Compensation or treatment for injury: Only for studies with greater than minimal risk
- Contact for questions: Research, subject rights, research injury
- Voluntary participation statement: Can withdraw at any time without loss of benefits

Tips to speed IRB approval

- Identify problem areas through early discussions with IRB members and experienced researchers
- Use outlines and templates from human subjects web page
  - These satisfy Federal requirements and are updated frequently
- Use minimum number of subjects needed to meet research goals
  - Justify subject requirements with power analysis or prior literature

Common IRB Pitfalls

- Using technical jargon in the protocol and the informed consent document
- Introducing oral changes at the IRB meeting
- Failure to include subject recruitment material
- Using only subject populations of "convenience"
- Failure to recognize sources of undue influence in subject recruitment, selection and participation
- Inadequate or over-extended data protections

- Keeping data for longitudinal research without consent

After Your Protocol is Approved

- The PI ensures that the research complies with human subjects protections and is conducted IAW approved protocol
  - Modifications require IRB approval
  - Monitor research and activities of associate investigators
  - "Adverse events" reported immediately to the IRB
  - Significant changes to risk/benefit reported to the IRB
- Provide progress and final reports
- Submit signed informed consent documents to XPR (for permanent archiving) after completion of research

IRB Resources

- Guidelines and instructions available from:
  - USAFA IRB web site: http://www.usafa.af.mil/dfe/herc/subjects.htm
  - USAFA IRB Administrator (XPR, 719-333-2587) or IRB Chair (Dr Miller, 719-333-2804)
  - IRB members, Department research directors and mentors, and Federal, DoD and AF policy documents (policy documents at USAFA IRB web site)

Surveys - Design, Administration, Analysis, Utility, Lessons Learned, Minimums, Better and Bests (Workshop)

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Abstract: Optimizing the utility of survey results was the primary focus of this workshop. The presenters have authored, co-authored, administered, analyzed, and given feedback on dozens of surveys over the past year to groups as small as 25 to as large as 225,000. Real-life successes and failures reinforced many survey issues to include establishing timelines, cost-benefit tradeoffs, protecting respondent privacy, optimizing participation, sampling strategies, and analysis/communication of results.

Survey Planning

- Goal: Establish survey needs
  - Determine data needs
  - Establish data constituents
  - Develop timetable
  - Evaluate past experience/instruments/data

Survey Development

- Goal: Translate data needs into survey items
  - Develop items and validate to objectives
  - Draft the survey instrument
  - Establish administration methods
  - Coordinate with impacted offices

Survey Piloting

- Goal: Validate methodology and instrument
  - Administer the pilot instrument
  - Evaluate pilot data
  - Validate items, methodology and analysis plan
  - Implement changes and lessons learned

Survey Administration

- Goal: Facilitate survey experience and obtain quality data
  - Logistic preparation
  - Improving data quality through administration and participation
  - Data protection
  - Respondent and customer follow-up

Survey Analysis

- Goal: Provide data that meet customer needs
  - Establish customer interest and sophistication
  - Determine kinds of data to be provided
  - Descriptive vs. inferential statistics

- Responses from open-ended items
- Effect sizes
- Ancillary findings from data

Reporting Survey Results

- Goal: Provide survey results in a usable format
  - Establish presentation medium (report, talker, presentation, etc.)
  - Organize results according to customer priorities
  - Communicating complex statistical results
  - Aiding interpretation of results
  - Providing recommendations

After the Survey

- Goal: "Close the loop"
  - Provide feedback to survey participants
  - Disseminate survey results
  - Assess survey effort-- improvements to instrument, administration, analysis and reporting
  - Support customer "change team"

Top 10 Survey Mistakes

- Assure yourself that the same mistakes won't happen again.
- The longer the survey, the better it will be.
- Make the survey your own, and *only* your own.
- Make sure the survey is unexpected.
- Piloting is worthless, the survey works for me.
- Survey administration: What me, worry?
- More analysis is better, leave no stone unturned.
- Results: Better right than when needed.
- Keep your results quiet.
- You're done when the survey's picked up and the lights are turned out.

Survey Resources

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Writing for Publication (Workshop)

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Abstract: In this workshop faculty members learned basic writing, editing, and targeting strategies to help their work reach a wider audience. This workshop dealt with issues such as getting started, selecting appropriate journals, soliciting assistance, and preparing the manuscript, including editing techniques. Participants were encouraged to share "works in progress" with the idea that this initial meeting would be only the beginning of supportive help from USAFA colleagues. The facilitator shared a model for a "writers' support group" active at Keane College.

"Writing is a way to learn, not merely a means of communicating to others what has already been mastered. It is a critical tool of invention and discovery central to all disciplines."

Elaine Maimon

Although the United States Air Force Academy prides itself on its teaching mission, research also plays a critical role here. Regardless of one's discipline, research involves dissemination, sharing the results with others through conference presentations and scholarly papers. Invariably, this dissemination requires putting pen to paper or more likely now, fingers to keyboard. Given the demands on our time at USAFA, producing first-rate journal articles, books, or conference presentations/proceedings, can be a daunting task.

Some of these challenges are identified in Kenneth Henson's (1995) interesting list of "Six Myths that Haunt Writers," which focuses specifically on academic writing: (1) I'm not sure I have what it takes; (2) I don't have time to write; (3) I don't have anything worth writing about; (4) The editors will reject my manuscript because my name isn't familiar to them; (5) My vocabulary and writing skills are too limited; and, (6) In my field there are few opportunities to publish.

The first step for some of us is learning to identify and overcome some of these writing inhibitors.

Causes of Writing Problems

"What can I do in Poetry/ Now that the good Spirit's gone from me?/Why nothing now, but lonely sit,/And over-read what I have writ." —Robert Herrick

As this jingle by a seventeenth-century poet suggests, writer's block is nothing new. We can imagine the earliest cuneiform scribes laying out their chisels, much as Ernest Hemingway laid out his sharpened pencils. Robert Boice (1990) has identified some causes of writing problems that might help would-be authors identify some of the causes of potential paralysis. Some of these, such as fear of failure, lack of confidence, or a tendency toward perfectionism, are internally generated. The first two can prevent a would-be writer from starting a project at all; the latter can result in an inability to finish writing or an unwillingness to, as Tara Gray (1998) puts it, "Kick it out the door—and make 'em say 'no.'" Sometimes these inhibitors may occur because of early negative writing experiences, such as vivid imagines of Mrs. Grundy squinting over granny glasses at her cowering pupils, bun pulled tightly back and ruler in hand. Or, they may result from a desire to avoid the irritability or

obsessiveness that Boice suggests can arise from "binge writing," writing frenetically in huge, unhealthy chunks of time.

Sheer procrastination probably tops everyone's list of writing problems. Given our busy schedules and our commitment to open door policies, it is easy to postpone that first draft in favor of extra instruction or a required committee meeting. Boice mentions The Law of Delay ("That which can be delayed, will be") with the assertion that, "The priority principle simply says that if you're not writing as much as you would like, you're not making writing a realistic priority" (p. 75).

Despite the obstacles Boice and Henson identify, some specific approaches seem to help faculty members become productive writers.

Overcoming Writer's Block

"The Priority Principle: That which can be delayed, need not be." —Robert Boice

To get "unstuck," virtually all writers recommend a technique called "free writing" advocated by Peter Elbow (1998; 1998). Free writing is simply a brainstorming technique where one writes rapidly and nonjudgmentally about ideas related to the topic. Elbow recommends writing continuously for ten minutes, even if the product seems pointless or nonsensical, such as, "This is a stupid activity. I'll never get this article finished." Debbie Ridpath Ohi (1998) puts it this way: "The best thing to do is to brainstorm, which is write down whatever comes to mind about the subject you are working on. It may not help you immediately, but it gives you ideas, which lead to even more ideas. Writing stream-of-consciousness style will usually reveal the thoughts, topics, inspiration that your brain is withholding from you."

Boice suggests uses "free writing" as the foundation of an approach he calls "generative writing." After the brainstorming period, he suggests reflection, an editing phase where writers combine similar ideas and refine prose for consistency in direction, voice, and audience. The sequence is repeated as often as it takes to complete a draft.

Many writers employ techniques that work specifically for them, such as taking a brief walk or listening to music. For scholarly work, two approaches work well: (1) Some writers have learned to jump ahead to write a section of the book or article that they know best. Focusing on the easy parts gets the creative ideas flowing; and (2) Reviewing research notes and rereading what is already written can help ideas to "jell."

All successful writers encourage others to write often and regularly. Boice urges us, for example, to "Abandon the notion that writing is best done in large, undisrupted blocks of time. Write in small regular amounts when you are most fresh. Work on 'doable' blocks, specific, finishable units of writing each session" (p. 77). This is probably the hardest advice of all. For academic researchers, it is also essential to establish a scholarly mind set.

Establishing a Scholarly Mind Set

Learn to swallow criticism whole, "the way an owl eats a mouse." --Peter Elbow

Research writing strategies never come in a one-size-fits all format. But here are some proactive things that any of us can do:

- Surround ourselves with the academic resources we need. We must be certain that the library, our department, or our household receives appropriate books, journals

or whatever else we need to stay current in our fields. Personal expenditures may be necessary: fortunately, they are tax deductible.

- Foster "cutting edge" contacts or relationships. Conferences, Listservs, former colleagues, and our Air Force affiliations can provide opportunities for critical networking.
- Practice the art of scholarly reflection. We should always be on the look out for that new angle, that unexpected insight, or that blinding period of creative thinking. We must try to RECORD everything, whether in a journal, on index cards, or in our computer databases.
- Strike while the iron (or the brain) is hot. Following this advice may mean for some of us nocturnal visits to the computer, a puzzling practice to significant others, offspring, and family pets.
- Despite listening to our muse when it hits us over the head, we can't always rely on inspiration. Developing productive work habits is essential.
- Think in terms of multiple publications, spin-offs, connections, or different journals. Results of a scholarly study published in a research journal might have practical classroom applications, for example, that could be shared through less formal publications such as College Teaching.
- Self-congratulation is not enough. We need to take advantage of peer review options and opportunities by enlisting advice from our colleagues here and at other institutions.

This last idea is probably the most critical. Boice calls helping others "missionary work," a term that resonates well with our core value of "Service before Self." A second pair of eyes—and preferably more!—can give us new perspectives and help us put ourselves in the place of the reader. He recommends: “Share your writing with supportive, constructive friends before you feel ready to go public. If other readers know they're being asked to appraise writing in its formative stages, they'll feel less judgmental and more inclined to offer advice for changes” (p. 78).

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Fitting Courses Together to Make a Better Curriculum

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Robert K, Noyd, Ph.D.
Department of Biology

Abstract: Our paper describes a process the USAFA Biology Department is using to review and create a new curriculum. The final product will be a collection of "course charters," which describes the department's expectations for required courses in the major. With expectations outlined, each course fits together to form an integrated curriculum.

Rationale for Redesigning Our Curriculum

Introduction. We have been operating with an "implicit curriculum." As a loosely knit collection of courses, the implicit curriculum simply listed required courses, stated prerequisites, and suggested a course sequence. As a result, the department's "product" (the student major) and educational goals were ill defined, vague, and were not readily apparent to administrators, faculty, or students. Without a clear set of educational goals, it was difficult to assess our curriculum's strengths and weaknesses. More importantly, there was no sound basis for making important curriculum decisions, improvements, or changes.

Problems with the Implicit Curriculum. For us, the implicit curriculum has produced several problems and issues at the course level. The implicit curriculum left circumscription and development of content and skills entirely to instructors. Thus, each course evolved along its own path and the curriculum was simply a sum of all courses in their particular stage of development. The fact remained that courses did not operate independently; upper level courses depended on the content and skills of introductory courses. Furthermore, the lack of curriculum integration and cohesion lead instructors to assume that students came to their classes with a specific set of skills (i.e. writing, statistical) or a depth of content knowledge. These assumptions arose from a poor understanding of the content areas, the skills developed, or the projects required by other courses. For example, instructors of our senior seminar course expected that students came with the ability to write in a scientific paper format and could analyze a paper's strengths and weaknesses. Upon examination, we found that students had never been required to do this prior to the senior seminar course, leaving a gap in their background. We also found content areas between courses that essentially repeated the same material. Problems associated with a lack of course integration increased with retirements and faculty turnover when new instructors were left with little guidance in the role of their courses in the curriculum and specific content areas to address.

Defining Curriculum. We directly confronted these issues by attempting to fit courses together to create an integrated curriculum, one that specifies its goals and defines its product. We viewed the product of our curriculum developmental efforts to be a set of general knowledge, skills, and attitudes (KSAs) we intend to develop in our students on a department basis and specific outcomes on a course-by- course basis. Ultimately, each required course has a specific role in the curriculum, a set of KSAs assigned to it by the curriculum. We call this document of expectations a *course charter*. Inherent in the charter concept is a philosophy that a course serves the curriculum.

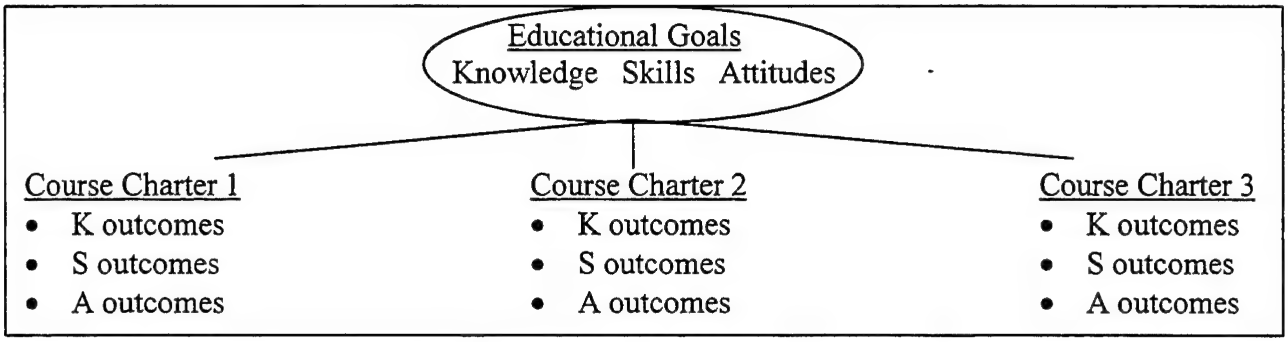

Figure 1. The process.

Building a New Curriculum -- the Department of Biology's Process

Introduction. Our curriculum has a top down structure (Figure 1). At the top, outlining the curriculum, are the department's educational goals. The educational goals describe, in broadest terms, the knowledge, skills and attitudes we want our required courses to instill into our biology majors. Below the goals we place our course charters--the heart of the curriculum. Each charter is a listing of outcomes, and describes the educational intent of the course. Each outcome is actually a sub-category of an educational goal, and thus is linked to the over riding guiding principles. Functionally, the outcomes define more specifically the knowledge, skill, or attitude the course is charged with passing on to our students. Our challenge, in building a curriculum, was to define our educational goals, create outcomes, and assemble them into course charters.

Defining the Educational Goals. One faculty member researched and drafted a set of educational goals. As a faculty, we then clarified and validated the goals in a series of small group meetings that promoted discussion and proved to be quite productive. A validation of the goals was critical to creating , and prevent the appearance of micro-management from leadership. Without the validation of the faculty, members may have viewed the goals as dictates from on high.

Creating Outcomes. With goals written, the next step involved writing outcomes for each goal (a knowledge area, skill, or attitude). We formed seven small committees of 3-4 faculty members. All faculty members participated. We asked each committee to write outcomes for a single goal. To ensure timeliness, we assigned a facilitator to each committee, established a reasonable timeline with deadlines, and provided written guidance on writing outcomes. To increase the likelihood of a faculty wide consensus on the outcomes, we encouraged inter-committee communication by publishing each committee's work. Thus, members of each committee could read and provide feedback on all the outcomes. In addition, we held three small-group meetings (one member from each of the seven committees) to discuss the outcomes. Using small committees to write our outcomes eased logistics, and permitted us to tackle many goals simultaneously. Input from the entire faculty created synergism, and increased buy-in to the project.

Assembling Charters. After writing their outcomes, and gaining approval from the department, the committees decided which specific required course should address each of their outcomes. Thus, we did not create courses to carryout our outcomes. Rather, we used the required courses that currently constitute our curriculum. In addition to assigning the outcomes to courses, the committees determined the degree of emphasis it expected for each

outcome. It indicated the degree of emphasis by assigning each outcome a designator from a three-tiered scaled. Thus, course directors have some indication of the relative importance of each outcome in their course charter. To assemble a charter for a single course, we simply listed all the outcomes assigned to the course. To validate the reasonableness of the each committee's charter, we are now asking the current course instructors to review the charter.

Other Considerations

- *Communications.* We found it vital to maintain communications with the faculty. To that end we created a newsletter. We used the newsletter to address changes in processes, announce meetings, and publish the work of the committees.
- *Common Terminology.* For the faculty to cooperate in this venture they needed to have a common vocabulary of curriculum development. We published a glossary of terms, and explained terms in our start-up meeting. Thus, faculty could discuss outcomes and goals without confusion.
- *Establishing a Time Frame.* Long term projects demand concrete end point, other wise they never come to completion. In addition to defining an end, we established milestones to keep the project moving forward.

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Appendix

List of USAFA education researchers, January 1999

Org	*Title*	*First Name*	*Last Name*
Basic Sciences Division			
DFB	Col	James	Kent
DFB	Dr	Bob	Noyd
DFC	Dr	Don	Bird
DFC	Lt Col	Ron	Furstenau
DFC	Maj	Matt	Morgan
DFCS	Capt	Tim	Chamillard
DFMS	Maj	Scott	Blum
DFMS	Capt	Bob	Clasen
DFMS	Lt Col	Steve	Hadfield
DFMS	Capt	Trae	Holcomb
DFMS	Dr	Brad	Kline
DFMS	Maj	Glen	Sjoden
DFMS	Capt	Scott	Williams
DFMS	Capt	Frank	Wilson
DFMS	Maj	Kevin	Yeomans
DFP	Col	Rolf	Enger
DFP	Dr	Heidi	Gruner
DFP	Dr	Evelyn	Patterson
DFP	Capt	Tom	Summers
Engineering Division			
DFAN	Dr	George	Havener
DFAS			
DFCE	Lt Col	Jim	Pocock
DFEE	Dr	Dan	Pack
DFEM	Capt	Rob	Borchert
DFEM	Dr	Dan	Jensen
DFEM	Capt	Michael	Murphy
Humanities Division			
DFENG	Dr	William	Newmiller
DFF	Lt Col	Judith	Brisbois
DFPY			
DFH			
Social Sciences Division			
DFBL	Lt Col	Tony	Aretz
DFBL	Lt Col	Bob	Berger
DFBL	Capt	Joey	Hickox
DFBL	Col	Dave	Porter
DFBL	Dr	Steve	Samuels
DFEG	Dr	David	Mullin
DFEG	Maj	Gerald	Sohan
DFL			
DFM	Dr	Jim	Lowe
DFPS	Dr	Frances	Pilch

Other DF			
DFE	Col	Randy	Stiles
DFER	Lt Col	Larry	Strawser
DFEX	Ms	Carolyn	Dull
DFEX	Mr	Ken	Grosse
DFEX	Dr	Barbara	Millis
DFEX	Maj	Marie	Revak
DFRL	Dr	Angela	Caron
DFV	Lt Col	John	Sherfesee
IITA	Dr	Peg	Halloran
IITA	Gen	James	McCarthy
Other USAFA			
34thEDG	Maj	Gregory	Elder
34thEDG	Maj	John	Higgs
34thEDG	Ms	Dolores	Karolick
34thEDG	Col	Larry	Smith
50thTS	Maj	Don	Tharp
CDC	Col	Chuck	Yoos
XPR	Lt Col	Bernard	Asiu
XPR	Lt Col	Lee	Leber